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EPA (Environmental Protection Agency) Macroscopic Planning Model (EPAMAC) for Stormwater and Combined Sewer Overflow Control: Application Guide and User's Manual

Metcalf and Eddy, Inc., Palo Alto, CA

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A simplified stormwater management model has been developed to provide an inexpensive, flexible tool for planning and preliminary sizing of stormwater facilities.

The model was developed to be part of a methodology for use in the management of stormwater that utilizes both simple computer programs and hand computations. The model consists of three uncomplicated but interrelated programs that can be used singularly or together. Capabilities of the model, in addition to quantity and quality analyses for stormwater flows, include dry-weather flow, hourly simulation, overflow event analysis, pollutant removals due to sedimentation in storage, and lateral inflows. Postprocessor programs can also provide histogram plots of flow and quality and analyses of receiving water coliform limitation violation days for several coliform standards.

The application of the model in San Francisco, California in support of the stormwater and combined sewage treatment master plan for the City and County of San Francisco is described in this report. Data from the San Francisco application are included in the examples presented.

A documentation of the model and instruction in data preparation and application are included in the User's Guide portion of this report.

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EPA MACROSCOPIC PLANNING MODEL (EPAMAC) FOR STORMWATER AND COMBINED SEWER OVERFLOW CONTROL

Application Guide and User's Manual

by

William G. Smith and Marianne E. Strickfaden
Metcalf & Eddy Engineers, Inc.
Palo Alto, California 94303

Contract No. 68-03-2877

Project Officer

Richard Field, Chief
Storm and Combined Sewer Program
Wastewater Research Division
Municipal Environmental Research Laboratory (Cincinnati)
Edison, New Jersey 08837

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

The deleterious effects of storm sewer discharges and combined sewer overflows on the nation's waterways have become of increasing concern in recent times. Efforts to alleviate the problem depend on characterization of these flows in both a quantity and quality sense. This report describes the development and application of a stormwater management macroscopic planning model that can be used to provide an inexpensive, flexible tool for planning and preliminary sizing of stormwater facilities.

Francis T. Mayo
Director
Municipal Environmental
Research Laboratory

ABSTRACT

A simplified stormwater management model has been developed to provide an inexpensive, flexible tool for planning and preliminary sizing of stormwater facilities.

The model was developed to be part of a methodology for use in the management of stormwater that utilizes both simple computer programs and hand computations. The model consists of three uncomplicated but interrelated programs that can be used singularly or together. Capabilities of the model, in addition to quantity and quality analyses for stormwater flows, include dry-weather flow, hourly simulation, overflow event analysis, pollutant removals due to sedimentation in storage, and lateral inflows. Postprocessor programs can also provide histogram plots of flow and quality and analyses of receiving water coliform limitation violation days for several coliform standards.

The application of the model in San Francisco, California, in support of the stormwater and combined sewage treatment master plan for the City and County of San Francisco is described in this report. Data from the San Francisco application are included in the examples presented.

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This report has been prepared in the Western Regional Office of Metcalf & Eddy, Inc., in Palo Alto, California, by William G. Smith, Project Manager, and Mrs. Marianne Strickfaden, Project Engineer, under the direction of John A. Lager, Vice President.

PART I

INTRODUCTION, CONCLUSIONS, AND RECOMMENDATIONS

SECTION 1

INTRODUCTION

Complex stormwater models provide valuable data for the design and final sizing of stormwater facilities. However, the detailed models generally require comprehensive detailed input data and large blocks of time on relatively large computers to execute. In an attempt to provide an intermediate step between the large, complex models and the traditional desk top analysis used in facilities planning projects, the EPA has participated in the development of several simplified computer models for planning and preliminary sizing of facilities. Two of the simplified models, which led directly to the development of the modes described in this report, were the subject of recent EPA reports [1, 2]. These simplified models require very moderate expenditures for data preparation and execution while providing a flexible tool for analyzing a variety of system configurations.

PURPOSE

The purpose of this report is to summarize the mathematical modeling work performed in support of the stormwater and combined sewage treatment master plan for the City and County of San Francisco and to provide a compact reference base for application of the model at future locations. The model consists of three uncomplicated but interrelated programs that can be used singularly or together. This allows the user to build on his individual data strengths and to focus on individual study objectives.

TASKS

In the application of the three programs, the following tasks are performed:

- Data preparation
- EPAMAC application
- Storage-treatment balance assessment
- Overflow quality assessment
- Treatment plant-overflow operation assessment
- Receiving water coliform limit violation assessment

Each task actually is a combination of computer program application and hand computations.

FORMAT OF PRESENTATION

The report presentation is organized into four parts. The first part of the report includes the introduction, conclusions, and recommendations.

The second part, SFMAC Model Applications, describes (1) objectives and application concept; (2) assumptions, capabilities, and operation; (3) model application procedures; (4) model results; (5) model effectiveness; and (6) management and modeling activities.

The third part, EPAMAC Model Documentation and User's Guide, includes (1) general description, (2) user instruction, (3) technical concepts, and (4) program documentation.

The fourth part includes the references, a glossary of key terms, a list of abbreviations, and conversion factors for U.S. Customary to SI (metric).

Three appendixes are incorporated into the report also. These appendixes are: (1) Appendix A, a listing of the programs and the variables in the programs; (2) Appendix B, a description of the verification of the San Francisco MAC model--SFMAC; and (3) Appendix C, a discussion of the selection of EPAMAC storage sedimentation variables.

SECTION 2

CONCLUSIONS

1. A schematic of the existing system of stormwater facilities, outlining major conduits and overflow discharge locations and sizes, is an essential part of the data preparation.

2. Overflow quantities and qualities must be measured to provide information for calibration of the model.

3. Gross averages of the quality data by subarea can provide an indication of overflow quality and areal trends in overflow quality.

4. The EPAMAC model is an outgrowth of the Macroscopic Planning Model (MAC) developed for the Association of Bay Area Governments San Francisco Bay Region 208 planning study and modified for use as a planning tool in San Francisco's Southwest Water Pollution Control Plant Facility Plan.

5. The EPAMAC model is a generalized version of the SFMAC model used during the development of San Francisco's Southwest Water Pollution Control Plant Facility Plan and Master Plan Review.

6. EPAMAC is a special purpose, continuous simulation model of surface runoff with minimal input data requirements, broad areal and temporal coverage, and both flexibility and ease of application.

7. Capabilities of the model, in addition to quantity and quality analyses for stormwater flows, include dry-weather flow, hourly simulation, overflow event analysis, pollutant removals due to sedimentation in storage, and lateral inflows. Postprocessor programs can also provide histogram plots of flow and quality and analyses of receiving water coliform limitation violation days for several coliform standards.

8. Information developed from use of the model (SFMAC) in San Francisco was used by the regional water quality enforcement agency in an evaluation of appropriate stormwater overflow frequency levels to be included in NPDES regulations. Pollutant loadings developed from SFMAC application and coliform violation day data from VDAY were used in cost benefit analyses to determine allowable overflow frequency levels consistent with beneficial uses of the shoreline, ocean, and bay waters.

SECTION 3

RECOMMENDATIONS

1. The EPAMAC model and postprocessor programs should be implemented as a preliminary design and planning tool.

2. The EPAMAC model should be used repeatedly to analyze various combinations of storage capacities and treatment plant rates to determine possible optimum conditions.

3. Areal trends in overflow frequency and quality should be determined using simple statistical techniques.

4. To minimize computer application costs, initial analyses should be made using short, typical rainfall periods (4 to 10 years). Only after initial screening should alternatives be analyzed using long-term (up to 70 years) rainfall records.

5. The EPAMAC model should be used to examine seasonal and yearly periods. The hourly and daily data that can be generated are not meant to be exactly representative of individual storm events due to the simplified nature of the program. Monthly and longer periods are reliable, but shorter periods are only general indications of what might be expected.

PART II

SFMAC APPLICATIONS

SECTION 4

OBJECTIVES AND APPLICATION CONCEPT

The involvement of the MAC model in the San Francisco wastewater planning process is described in this part of the report. This section specifically addresses the objectives of the planning process and concepts involved in managing a combined sewer system. The necessity of computer modeling to meet planning objectives and the model selection process are also presented.

SAN FRANCISCO WASTEWATER MANAGEMENT PLAN

The planning and development of wastewater facilities is the responsibility of the San Francisco Clean Water Program. This special projects group reports through the Executive Director to the city's Chief Administrative Offices, who in turn report to the Mayor and the Board of Supervisors for the City and County of San Francisco. Facilities developed must comply with San Francisco Bay Regional Water Quality Control Board (RWQCB) and federal EPA regulations.

The unique physical setting of San Francisco must be considered in the development of wastewater facilities. It is located on a peninsula, which allows for the option of either bay or ocean effluent discharge. The planning area contains 23 watersheds comprising 28,550 acres (11,554 ha) that contain numerous hills and peaks. Much of the land slopes steeply to the water, although a flat coastal strip exists along the east side of the city. Rainfall occurs mainly from October through May, and average annual rainfall is about 20 inches (51 cm).

Previous planning efforts and water quality objectives influencing wastewater facility selection are discussed in the following paragraphs.

Plans

The San Francisco Master Plan, 1971, established the goals of upgrading the wastewater treatment level and reducing the frequency and volume of wet-weather overflows [1]. The concept of the plan was to consolidate the 43 existing overflow points, to install retention basins, and to provide one wet-weather treatment plant on the ocean side of the city. Storing of storm flows and reducing the number of pumping stations were an integral part of the master plan concept.

The report Water Quality Control Plan: San Francisco Bay Basin, 1975, resulted from a review and update of the Master Plan concept and focused on wet-weather overflow control and secondary treatment of dry-weather flows [2]. Ocean disposal of wet- and dry-weather flows was favored. Overflow control zones were established to protect identified beneficial uses of the receiving water along various segments of the shoreline. The suggested annual overflow frequency varied from 0.2 to 8.

The next planning development was the Overview Facilities Plan, 1975, which focused on the balance between storage, transport, and treatment phases of handling stormwater runoff [3]. Planning now had reached a stage of complexity where further progress would require numerical analysis.

The Southwest Water Pollution Control Plant Facilities Plan, 1980, utilized the SFMAC model to analyze systemwide alternatives [4]. The focus of Part II of this report is to describe how the SFMAC model was used during the development of the Southwest Water Pollution Control Plant Facilities Plan.

Water Quality Objectives

Discharge requirements have been set by the RWQCB to achieve ambient water quality consistent with environmental and beneficial uses of the bay and ocean. Representative National Pollution Discharge Elimination System (NPDES) dry- and wet-weather permit requirements are listed in Tables 1 and 2. The limits set in the permits reflect Basin Plan [2] and Ocean Plan [5] criteria.

COMBINED SEWAGE FLOW ANALYSIS

The San Francisco sewer system conveys both dry- and wet-weather flows. To advance the planning concepts further and to meet the water quality requirements, a citywide computer modeling approach was necessary. During dry weather, major concerns are transportation and treatment of the flows and the resulting quality of the effluent. Wet-weather concerns also include the storage and pumping balance to minimize overflow volume and frequency, along with maximizing overflow and effluent quality. Since flows from different sections of the city influence one another, the reaction of the whole system to a storm event or series of storm events must be examined. Runoff volumes from all 23 watersheds need identification and integration to obtain guidance on facilities necessary to process the flows cost effectively. Such an analysis needs to be accurate enough to be reliable but not so involved that it would hinder the planning process. Computer simulation using an appropriate model would

Table 1. SUMMARY OF DRY-WEATHER NPDES PERMITS [1]

	North Point	Southeast	Richmond-Sunset	Southwest[a]
Waste flow, Mgal/d				
Average (1974 dry weather)	65.2	21.3	21.8	120.0[b]
Additional wet weather	--	--	--	215-800
Effluent limits, 30-day average				
BOD_5, mg/L	30	30	30	30[c]
Suspended solids, mg/L	30	30	30	30[c]
Chlorine residual, mg/L[d]	0.0	0.0	0.0	0.0
Fecal coliform, MPN/100 mL	--	--	--	200
pH	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0
Total coliform, MPN/100 mL[e]	240	240	--	--
Settleable solids, mL/L·h	0.1[f]	0.1[f]	--	--
Effluent limits, ≤50% of time				
Grease and oil, mg/L	--	10[g]	10	10[c]
Floating particulates, mg/L	--	--	1.0	1.0[c]
Settleable solids, mL/L·h	--	--	0.1[h]	0.1[c]
Turbidity, Jtu	--	--	50	50[c]
Arsenic, mg/L	0.01[i]	0.01[i]	0.01	0.01
Cadmium, mg/L	0.02[i]	0.02[i]	0.02	0.02
Total chromium, mg/L	0.005[i]	0.005[i]	0.005	0.005
Copper, mg/L	0.2[i]	0.2[i]	0.2	0.2
Lead, mg/L	0.1[i]	0.1[i]	0.1	0.1
Mercury, mg/L	0.001[i]	0.001[i]	0.001	0.001
Nickel, mg/L	0.1[i]	0.1[i]	0.1	0.1
Silver, mg/L	0.02[i]	0.02[i]	0.02	0.02
Zinc, mg/L	0.3[i]	0.3[i]	0.3	0.3
Cyanide, mg/L	0.1[i]	0.1[i]	0.1	0.1
Phenolic compounds, mg/L	0.5[i]	0.5[i]	0.5	0.5
Ammonia (as nitrogen), mg/L	--	--	40	40
TICH, mg/L	0.002[i]	0.002[i]	0.002	0.002
Toxicity concentration, tu	--[j]	--[j]	1.5	1.5
Radioactivity, pci/L	--	--	100	100
Discharge prohibitions	<10:1 Dilution >67.7 Mgal/d ADWF	<10:1 Dilution[k] >100 Mgal/d ADWF	<100:1 Dilution <1,000 ft off-shore >27 Mgal/d ADWF	<100:1 Dilution <1,000 ft off-shore
Receiving water limitations				
Dissolved oxygen depression, %	--	--	<10	<10
Dissolved oxygen, mg/L	5.0[l]	5.0[l]	--[m]	--
Dissolved sulfide, mg/L	0.1	0.1	0.1	--
pH[n]	0.2	0.2	0.2	0.2
Un-ionized ammonia (as nitrogen), mg/L[o]	0.025	0.025	--	--
Grease and oil, mg/m^2	--	--	10	10
Floating particulates, mg dry wt/m^2	--	--	1	1
Final toxicity concentration, tu	--	--	0.05	0.05
Radioactivity, pci/L	--	--	100	100
Total coliform, MPN/100 mL	--	--	240	240[p]

Table 1 (Concluded)

	North Point	Southeast	Richmond-Sunset	Southwest[a]
Time schedule				
Chlorine residual				
Begin construction	--	Sep 1, 1975	Jan 1, 1976	--
Complete construction	--	Oct 1, 1976	Dec 1, 1976	--
Full compliance	Oct 5, 1975	Nov 1, 1976	Jan 1, 1977	--
Heavy metals and pesticides limitations				
Begin implementation of program for source control and compliance with pretreatment standards	Mar 1, 1975	Mar 1, 1975	Jun 1, 1975	--
Time schedule for compliance of all industries	Mar 1, 1976	Mar 1, 1976	Jun 1, 1976	
Full compliance	Upon completion of secondary treatment facilities	Upon completion of secondary treatment facilities	Jun 1, 1978	
Documentation of compliance	6 months after completion of secondary treatment facilities	6 months after completion of secondary treatment facilities	Jul 1, 1978	--
Secondary treatment				
Begin design of enlarged primary facilities	Jun 23, 1975	Jun 23, 1975	--	--
Begin design of enlarged secondary facilities	Jun 23, 1975	Jun 23, 1975	--	--
Complete design of enlarged primary facilities	Jun 23, 1977	Jun 23, 1977	--	--
Complete design of enlarged secondary facilities	Jun 23, 1977	Jun 23, 1977	--	--
Full compliance	Jul 1, 1977	Jul 1, 1977	Jul 1, 1977	--
Outfall requirements and receiving water limits				
Program and time schedule	--	--	--	Aug 1, 1976[q]
Full compliance	Jul 1, 1977	Jul 1, 1977	Jul 1, 1977	--

a. Applies to both dry- and wet-weather unless otherwise noted.
b. Includes both Bayside and oceanside dry-weather flows in proposed consolidated outfall. Mass emission rates listed in permit are for 26 Mgal/d Southwest Plant secondary effluent.
c. RWQCB will consider modification of these concentration limits for wet-weather treatment plant effluent.
d. Instantaneous maximum.
e. Median of five consecutive samples.
f. Interim standards of 0.4 mL/L·h applicable until secondary treatment facilities completed.
g. 30-day average.
h. Interim standards of 0.5 mL/L·h applicable until secondary treatment facilities completed.
i. To be achieved through secondary treatment, source control, and application of pretreatment standards.
j. Survival of test fishes in 96 h bioassays: 90 percentile value of not less than 50% survival.
k. For flows up to the 70 Mgal/d outfall capacity. Flows in excess of 70 Mgal/d would be discharged to Islais Creek.
l. When natural factors cause lesser concentration(s) than those specified, then this discharge shall not cause further reduction in the concentration of dissolved oxygen.
m. Interim standard of 5.0 mg/L applicable until secondary treatment facilities completed.
n. Allowable variation from natural ambient level.
o. Applicable upon completion of secondary treatment facilities.
p. In shellfish harvesting areas, mean total coliform concentration shall not exceed 70 MPN/100 mL.
q. Does not apply to wet-weather discharge.

Mgal/d x 0.0438 = m^3/s

achieve analysis of a large number of alternatives in a reasonably short time.

Table 2. SUMMARY OF WET-WEATHER NPDES PERMITS [1]

	North Point sewerage zone	Southeast sewerage zone	Richmond-Sunset sewerage zone	Southwest WPCP
Discharge prohibition	<10:1 dilution	<10:1 dilution	<10:1 dilution	<1,000 ft offshore dilution: <100:1 dry weather <25:1 wet weather
Overflow frequency limitations (Allowable overflow events per year)	4 for all locations	10 for Central Basin and Islais Creek 1 for all discharges south of Islais Creek	8 for all locations	--

MODELS AND SELECTION CRITERIA

Once the needs for computer simulation were identified, the next step was to select an appropriate model. In San Francisco's case, none of the existing models exactly filled the needs of the project.

Summary of Available Models

Several models were investigated for their appropriateness to the San Francisco planning process. A list of major models is presented in Table 3. The models are listed in the table from large scale, many years of record, general planning use; to small scale, single event analysis, design detail scope.

Selection Criteria

The ideal model for San Francisco should have the following characteristics to meet the goals of the planning process:

- Large scale - does not require extensive input data and tests a large number of alternatives.
- Flexible - handles multiple watersheds and many different configurations, including time delays due to transport.
- Accurate - models both dry- and wet-weather flows and quality while maintaining numerical accuracy.
- Multiple events - uses long period of record (69 years of rainfall data available) and analyses for individual overflow event occurrences.

Table 3. CAPABILITIES OF SELECTED MODELS

Model		Catchment hydrology						Sewer hydraulics						Wastewater quality							Miscellaneous					General classification[a]
Origin	Acronym	Multiple catchment inflows	Dry-weather flow	Input of several hyetographs	Snowmelt	Runoff from impervious areas	Runoff from pervious areas	Flow routing in sewers	Upstream and down-stream flow control	Surcharging and pressure flow	Diversions	Pumping stations	Storage	Dry-weather quality	Stormwater quality	Quality routing	Sedimentation and scour	Quality reactions	Wastewater treatment	Receiving water quality simulation	Receiving water flow simulation	Can choose time interval	Design computations	Applied to real problems	Computer program available	
Metcalf & Eddy	SSWMM [6]	X			X	X	X						X		X				X	X	X	X		X	X	II
Corps of Engineers	STORM [7]				X	X	X				X		X		X			X						X	X	II
Hydrocomp	HSP [8]	X	X	X	X	X	X	X	X		X		X	X	X	X		X		X	X	X		X		II
Dorsch Consult	QQS [9]	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X		II
Metcalf & Eddy	ABMAC	X				X	X						X		X				X					X	X	Mini II
Metcalf & Eddy	SFMAC	X	X			X	X					X	X	X	X		X		X	X				X	X	II/III
MIT - Resource Analysis	MITCAT [10]	X	X	X	X	X	X	X		X	X		X								X	X		X		III
Battelle Northwest	BNW [10]	X	X	X		X	X	X		X	X		X	X	X	X			X			X	X	X	X	III
EPA	SWMM [11]	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	III

a. Level III has high input requirements and is design oriented;
Level II has low input requirements and is broad scale, planning oriented.

- Storage/treatment - tests the balance of storage, transport, and treatment of runoff for different alternatives.
- Data availability - uses readily available data for input and easily converts data to input format.
- Useful results - clearly addresses overflow event analysis and investigates receiving water impacts in output.

Examination of the models available showed that none met these characteristics; therefore, the SFMAC model was developed to fit the observed needs and revised at various points to better meet modeling requirements.

SECTION 5

SFMAC ASSUMPTIONS, CAPABILITIES, AND OPERATION

The thrust of this section is to introduce SFMAC, its characteristics, and its operational concerns. Discussion is sufficient to prepare the reader for understanding the application procedures and results. A detailed presentation of the model as revised to EPAMAC is included in Part III.

CHARACTERIZATION OF THE MODEL

The SFMAC model is an outgrowth of MAC developed for the Association of Bay Area Governments (ABAG), San Francisco Bay Region 208 planning [1], and the simplified stormwater management model [2]. MAC is a special purpose, continuous simulation model of surface runoff with minimal input data requirements, broad areal and temporal coverage, and both flexibility and ease of application.

SFMAC incorporates additional features including dry-weather flow, hourly simulation, overflow event analysis, and lateral inflows. A second outgrowth from MAC is ABMAC [3]. ABMAC maintains the daily time step of MAC but is adapted for use on minicomputers and to include input data preprocessing and streamlining.

Assumptions

All of the versions of the MAC model family compute the runoff volume as a function of the tributary area, rainfall, and a runoff coefficient similar to the rational method. The assumption is that the limitations inherent with this method are appropriate for use in a large-scale, continuous simulation model such as SFMAC. Runoff quality is assumed to be the same for each storm. However, to account for a first flush effect, the runoff quality associated with the first two hours of rainfall for a storm event can be specified. The runoff quality for the third and any subsequent hour of the storm remains constant through the duration of the storm.

The SFMAC algorithm also assumes complete mixing in storage each hour. For simplicity, the model presumes a constant percentage removal over varying waste stream concentrations for any flow receiving treatment; alternatively, a minimum treated effluent concentration can be specified. Other parameters, specific to San Francisco, incorporated in the model include: (1) a minimum of 0.025 in. (0.064 cm) of rain required to define a storm event, (2) a period of 6 or more hours without rainfall to terminate a storm event, (3) a period of 6 or more hours without an overflow to terminate an overflow event, and (4) a maximum time delay of 10 hours for lateral inflows.

The HISTO postprocessor program, which plots the results from SFMAC, simply uses the previous results to prepare histograms of the flow, concentrations, and mass loadings, and summary tables for each of these.

In the VDAY postprocessor program, the number of days the receiving water coliform concentration limits are violated are calculated. In VDAY, it is assumed that (1) the concentration of the coliforms in the receiving water is directly related to the volume of the overflow reaching the receiving water; (2) there is a minimum background coliform concentration in the receiving water; and (3) the concentration of coliforms in the receiving water resulting from dilution, dispersion, and die-off is based on the following formula:

$$C_o = \alpha K N^{\beta} \quad (1)$$

where C_o = coliform concentration in the receiving water at end of overflow, MPN/100 mL

α = correction factor

K = initial coliform concentration multiplier

N = number of coliforms in the overflow, MPN·acre·in./100 mL (MPN·ha·cm/100 mL

β = coliform attenuation coefficient, h^{-1}

Capabilities

The SFMAC model has the capability of using up to 98 years of hourly rainfall record, and 6 land uses with associated coefficients and acreages, supplied by the user. Stormwater runoff can be determined for up to 99 subareas in one run. The size of the computer system on which the program is run may limit the number of subareas that can be used to something below the capabilities of the program. The quantity and quality of the runoff can be combined with dry-weather flow and quality, and up to four lateral inflow streams. A schematic of flow routing is shown in Figure 1.

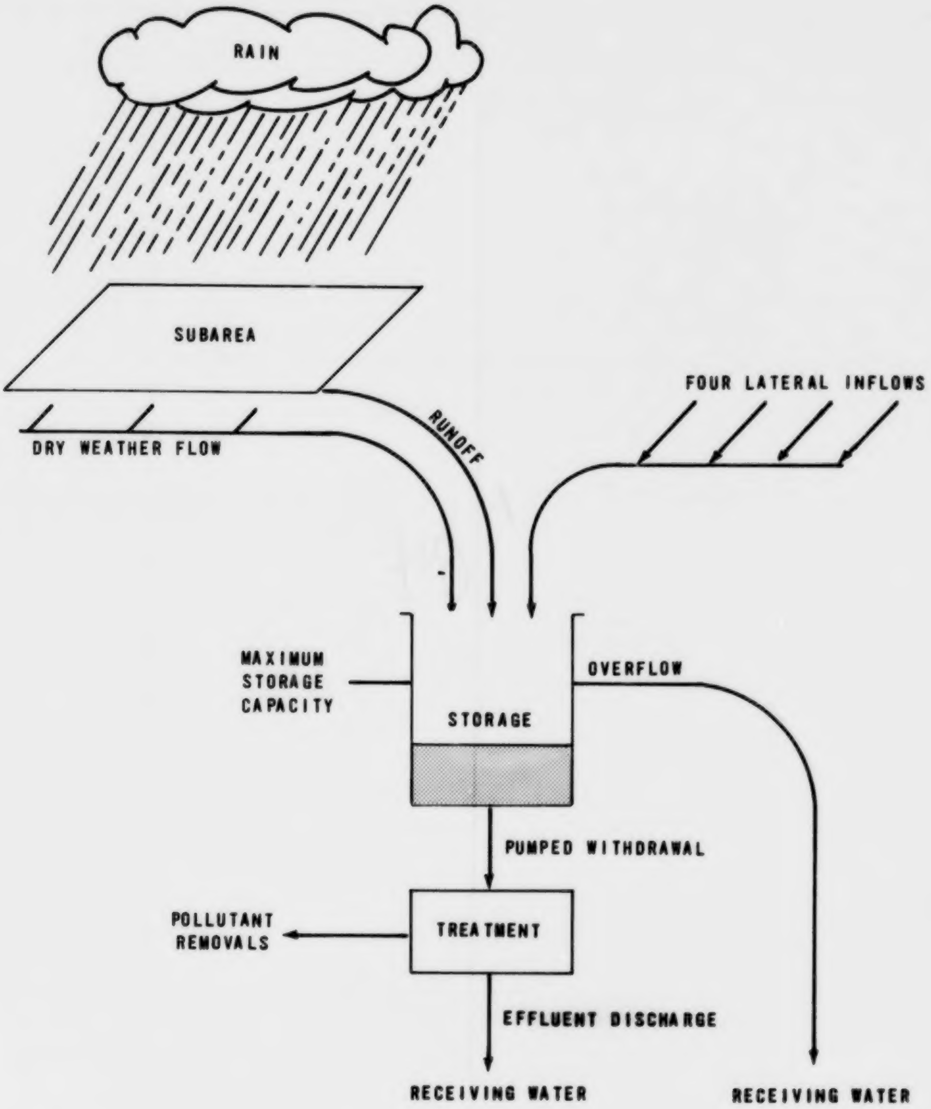


Figure 1. SFMAC flow schematic.

The lateral inflows can be time delayed to better approximate system travel time effects. Three storage and pumping modes can be specified to determine their effect on the quality and number of overflow events. Three overflow definitions are also available to the user. Treatment is optional with either of two modes of specifying effluent quality, percent removal, or constant effluent concentration.

Summary statistics are provided; the user has four printout frequency options (hourly, daily, monthly, or yearly). Three choices of quality data printout also allow flexibility as to the content of the output. Some error messages and consistency checks are included in the program. Two separate output files for each subarea and multiple rain input files can be specified.

The postprocessor programs can be used to have the ability of analyze selected output files.

HISTO plots hourly values for flow, concentration, and mass load--limited only by the length of the SFMAC output file. Summary tables for these hourly values are prepared also. The user may choose which of these parameters (all or any combination) are to be printed. The user may also select any specific time period from the output file for the printout. No new files are created by this program.

VDAY calculates the number of days for which the receiving water coliform concentration exceeds specified limits. Calculations are made on an hourly basis, but results are printed based on the values at noon for any particular day. The user may specify the time period for which results are to be printed. Statistical analyses of the results based on both an arithmetic normal distribution and on the ranked values are determined.

Restrictions

At best, all models are an approximation of reality and result in some limitations in their use. SFMAC only models BOD and SS. Other pollutants can be added by incorporating code parallel to that for BOD and SS. No provision is included for pollutant removals in storage. The wet-weather quality is approximated by only three input concentrations. Some preprocessing and checking of input data are included but are not extensive. All input cards must be repeated for each subarea. If a watershed requires more than four lateral inflows, multiple runs are necessary to incorporate them all. The units used in the printout are Mgal, klb, and mg/L, only.

HISTO makes hourly HISTOGRAM plots of the flow, concentration, and mass loads associated with an EPAMAC output file. Only those days for which there is flow are plotted. However, each plot contains the results for two consecutive days, even if the second day does not have any flow. This is done to avoid having a plot appear as the results for a single storm when there has been one or more intervening days with no flow.

VDAY is limited to processing 70 consecutive years of record. The computer storage required by the arrays used in the computations makes this limit necessary. Five receiving water coliform concentration limits are included in the program, based on the limits included in the NPDES discharge permits for San Francisco for both body contact recreation and shellfish. The three body contact recreation limitations are (1) events greater than 10,000 MPN/100 mL, (2) 5-day median greater than 240 MPN/100 mL, and (3) 30-day 20 percentile greater than 1,000 MPN/100 mL. The two shellfish standards are (1) 30-day median greater than 70 MPN/100 mL and (2) 30-day 10 percentile greater than 230 MPN/100 mL.

OPERATION AND RELIABILITY

Operation of the SFMAC model is relatively straightforward, but requires familiarity with the system to be modeled for optimum use. Tests during the San Francisco application also investigated model sensitivity and reliability.

Input Requirements

Five categories of input data are required for SFMAC:

1. Hourly rainfall data, preferably a minimum of 10 years of record. If rainfall for a specific area is not available, a multiplier is applied to rainfall records of a nearby area.
2. Land use data. The type of land use and associated land areas are needed for each watershed.
3. The runoff coefficient corresponding to the selected land uses.
4. Dry-weather quality concentrations.
5. Miscellaneous control parameters specific to the subareas and output desired.

HISTO requires an SFMAC output file to provide the flow, concentration, and mass load input. It also requires four other inputs:

1. Basic title information for the headings in the printout.

2. The start and stop dates (if only a specific period is to be plotted) and the selection of general plot and print options.

3. Specific plot and/or print options for the various parameters.

4. The values to be included in the plot headings and/or summary tables.

VDAY also requires an SFMAC output file as input. Four additional input categories are required:

1. Title information for the printout.

2. The start and stop dates if only a specific period is to be printed.

3. Information on the overflow event definition and the desired print options.

4. Variables used in the coliform concentration equation.

Sensitivity

The term sensitivity refers to the potential of errors in the choice of a parameter influencing the outcome of the modeling effort. Input variables with high sensitivity require more careful examination during selection. Alteration of the runoff coefficient produces a directly proportional effect on runoff volume. A doubling of the runoff coefficient doubles the flow and also the pollutant load for a wet-weather storm event.

Similarly, the input concentrations have a directly proportional effect on pollutant loads. It can be noted that the pollutant loadings are subject to higher variability because the runoff coefficient and input concentrations have a multiplicative effect on the loadings. The runoff coefficient is probably the most sensitive of the input parameters because of this dual influence.

Rainfall and area input also have directly proportional influence on the SFMAC results. Doubling the rainfall or watershed size doubles the runoff quantity if the runoff coefficient is held constant. The rainfall and area data should be determined as accurately as possible since these data are usually readily obtained. This should be done to maximize overall accuracy because other input data are inherently more uncertain and more difficult to estimate.

During storm events, wet-weather volume and quality predominate. Over a full year of record, however, dry-weather flow may contribute half of the total volume and pollutant load.

Therefore, dry-weather input must also be accurately assessed even though it is a less sensitive parameter.

Another area of sensitivity is the area of pumping and storage tradeoffs. Holding storage volume constant and varying pumping capacity can aid in determining the range of influence of pumping. The reverse process will indicate the range of storage influence. A given overflow level can be achieved by several pumping and storage configurations. Cost and desired dewatering procedures would aid in the final determination of optimum pumping and storage capacity balance.

Reliability

The reliability of SFMAC results depends on three factors. The use of a large number of rainfall records spanning 10 years or more is the most significant factor influencing reliability. Many years of record increase the repeatability of the results, and yield annual values and system characteristics that can be the basis of planning decisions.

The second factor involves the data base for determining the other input data. For example, if a sampling program were conducted to determine typical wet-weather pollutant concentrations, the user should ascertain if the wet-weather season was typical. If it were atypical, say drier than normal, the obtained concentrations, when applied over a long period, would bias the results. The values, in that case, should be either massaged to represent a best guess as to what typical is or verified by sampling during a second season.

The third aspect of reliability involves use of the results. Because SFMAC is a broad scale model, examining effects over seasonal and yearly periods of time, the hourly and daily data that can be generated are not meant to be exactly representative of individual storm events. Monthly and longer period results are reliable, but shorter periods are only general indications of what might be expected. A small-scale model would be needed to examine individual event character in any reliable detail, once that level of planning is required.

SECTION 6

MODEL APPLICATION PROCEDURES

The procedures used in applying SFMAC to San Francisco are discussed in this section. The steps of data collection, calibration, and production computer runs are described along with a description of participation by city staff.

SFMAC PROGRAM

The SFMAC model is comprised of the main model and two postprocessor programs. The main model program application procedure is presented first, and is referred to as SFMAC. The application of SFMAC can be categorized as initial preparation, calibration tests, and production runs. These three aspects are discussed, as well as the participation of San Francisco city staff in the modeling process. The procedures for applying the postprocessor programs are also presented.

Data Collection

The first step in applying SFMAC was the preparation of input data. This involved identification and gathering of watershed and collection system characteristic data. In previous planning efforts, 23 watersheds had been identified in the city. These watersheds and their grouping into the three primary watersheds are shown in Figure 2.

The population, area, and general character of each watershed were determined next. Information on watershed characteristics, potential sites for future storage facilities, and storage available in the existing system had been identified in previous planning efforts. Watershed data were reviewed and regrouped because systemwide alternatives modified individual watershed configurations.

The area associated with six different land use types was developed for each subarea. The data were then checked with other city data to confirm the results. Runoff coefficients for each area had been determined previously by the city, but were confirmed by land use weighting of typical urban runoff coefficients. The major watershed and subarea characteristics used in SFMAC are listed in Table 4.

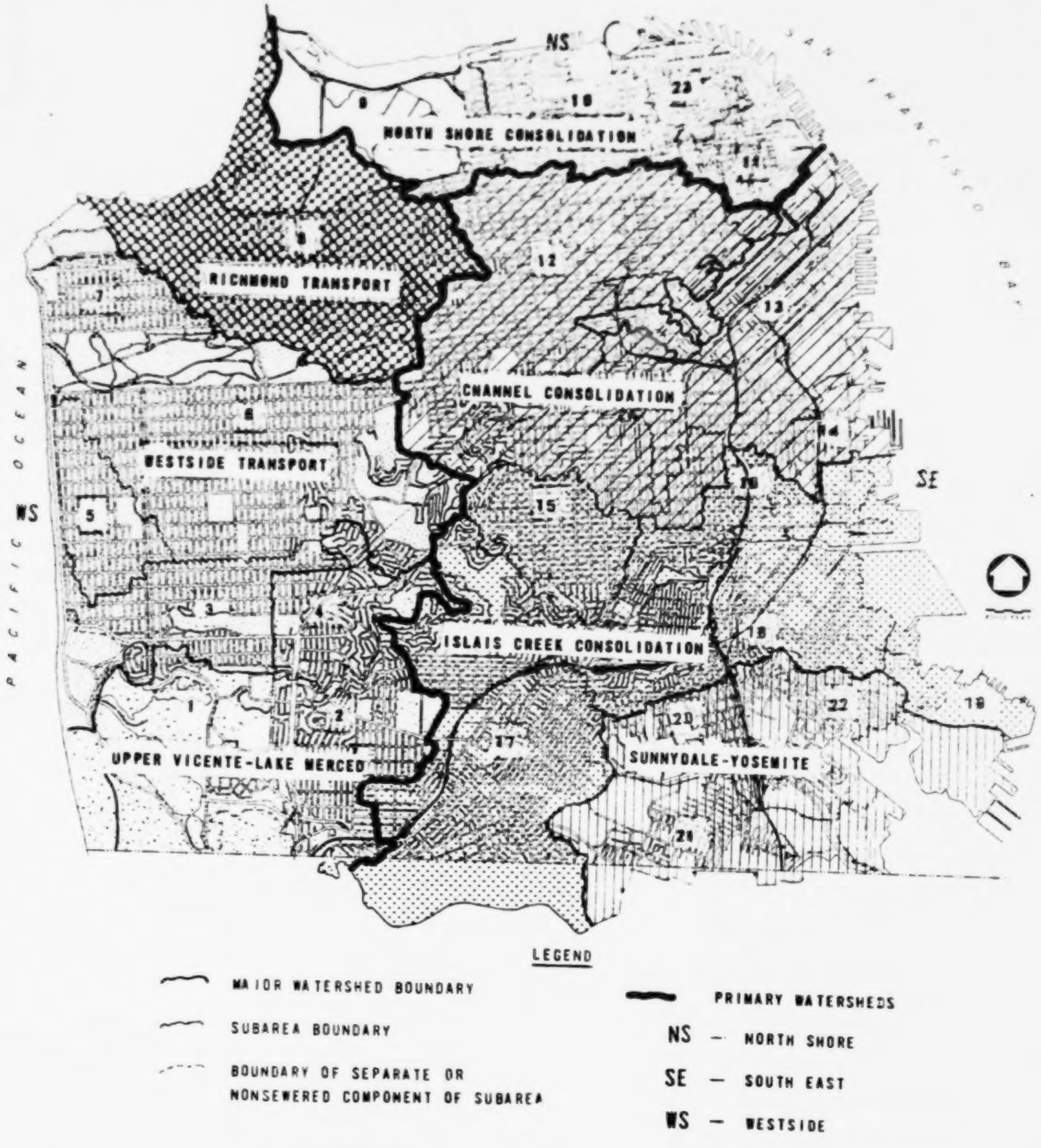


Figure 2. Subareas and major watersheds.

Table 4. MAJOR WATERSHED AND SUBAREA CHARACTERISTICS [1]

Major watershed	Subarea		Resident population[a]	Combined sewered area, acres	Gross runoff coefficient	Total area, acres
	Name	No.				
Upper Vicente-Lake Merced	Lower Lake Merced	1	9,709	538	0.60	1,170
	Upper Lake Merced	2	22,095	1,011	0.60	1,011
	Upper Vicente	4	13,124	703	0.63	703
Westside Transport	Lower Vicente	3	15,623	949	0.63	1,028
	WST Direct	5	16,609	562	0.61	562
	Lincoln Way	6	58,766	2,759	0.50	2,759
	Mile Rock	7	13,408	601	0.52	686
Richmond Transport	Seacliff-Richmond	8	58,919	1,990	0.51	2,484
Westside subtotal			208,253	9,113	0.55	10,403
North Shore Consolidation	Baker Street	9	8,768	241	0.60	1,091
	Pierce-Laguna	10	36,499	804	0.70	854
	Beach	23	18,284	372	0.75	372
	Jackson	11	22,764	772	0.75	772
North Shore subtotal			86,315	2,189	0.72	3,089
Channel Consolidation	Upper Channel	12	166,269	3,235	0.69	3,235
	Channel Interconnected	13	53,871	2,092	0.73	2,092
	Mariposa	14	3,837	235	0.64	271
Islais Creek Consolidation	Upper Army	15	20,199	755	0.60	755
	Lower Army	16	19,600	800	0.60	934
	Upper Selby	17	54,181	2,753	0.60	2,753
	Lower Selby	18	24,576	1,425	0.60	1,705
	Evans	19	3,548	62	0.60	389
Sunnydale-Yosemite	Upper Yosemite	20	7,150	552	0.55	552
	Lower Yosemite	22	11,847	798	0.66	1,386
	Sunnydale	21	13,002	986[b]	0.60	986[b]
Southeast subtotal			378,080	13,693	0.64	15,058
Totals			672,648	24,995[b]	0.61	28,550[b]

a. Based on 1975 Association of Bay Area Governments (ABAG).

b. Includes small portion of north San Mateo County tributary to San Francisco system by gravity.

acre x 0.405 = ha

Rainfall input data were developed from two sources. The first source was a network of 30 gages that the City of San Francisco established in December 1971. Four-year (1972-1976) rainfall information for each of the 23 subareas was synthesized using the Thiessen polygon method from the 30-gage network, shown in Figure 3. The second source was the National Weather Service (NWS) which has maintained a recording gage in San Francisco since January 1907. The NWS gage record for the 69-year period (1907-1976) was compared with the 4-year synthesized data set. The storm duration, intensity, and magnitude characteristics of both sets of data showed very close agreement, as illustrated in Figures 4, 5, and 6.

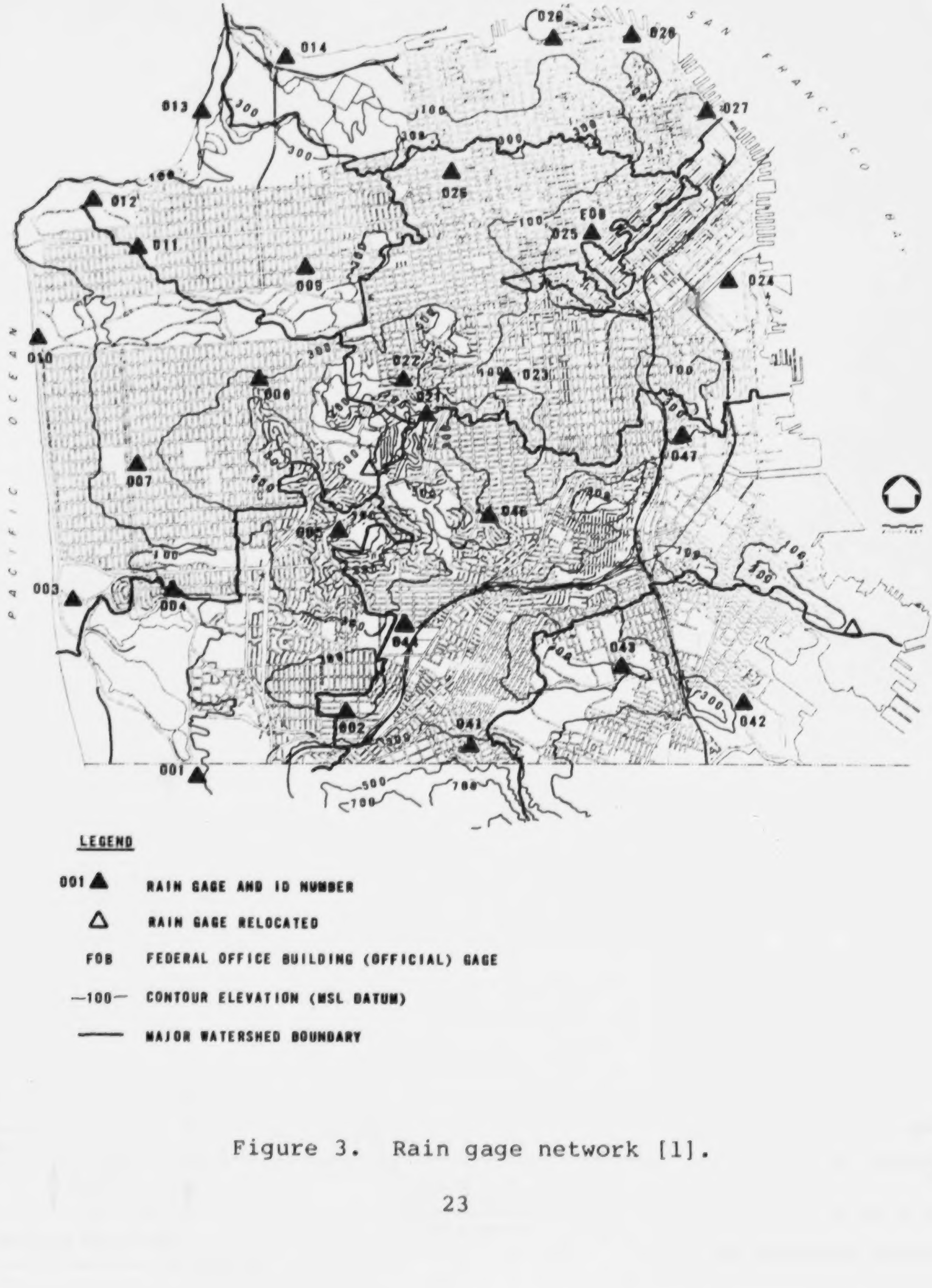


Figure 3. Rain gage network [1].

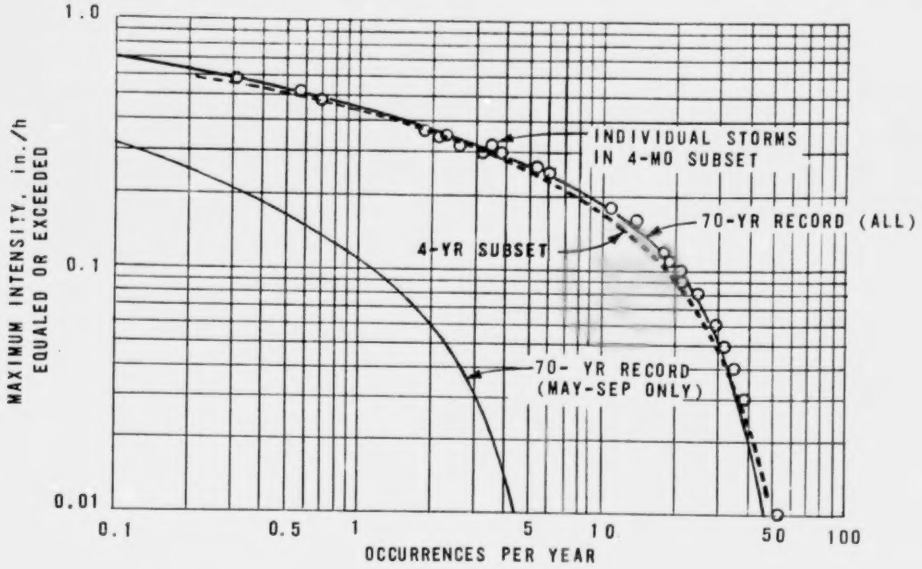


Figure 4. Storm duration versus frequency [1].

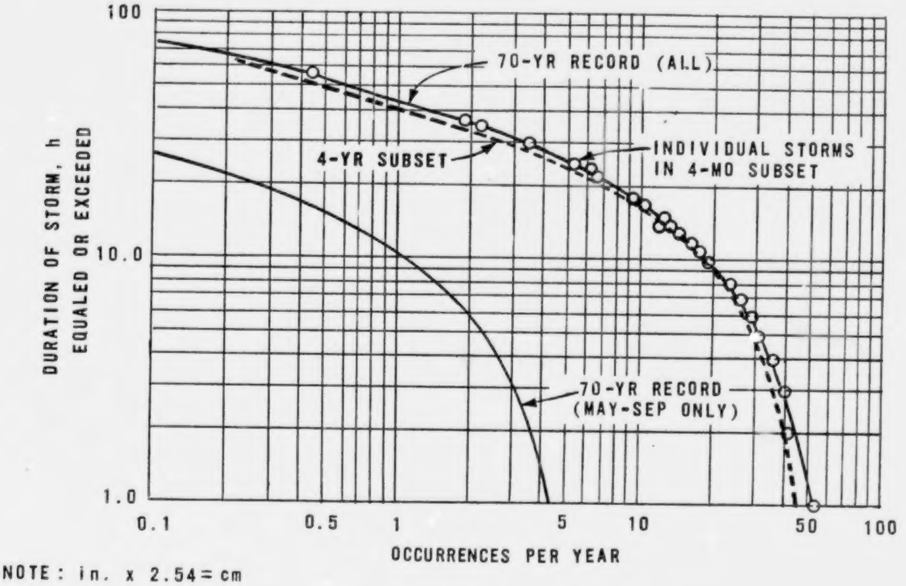
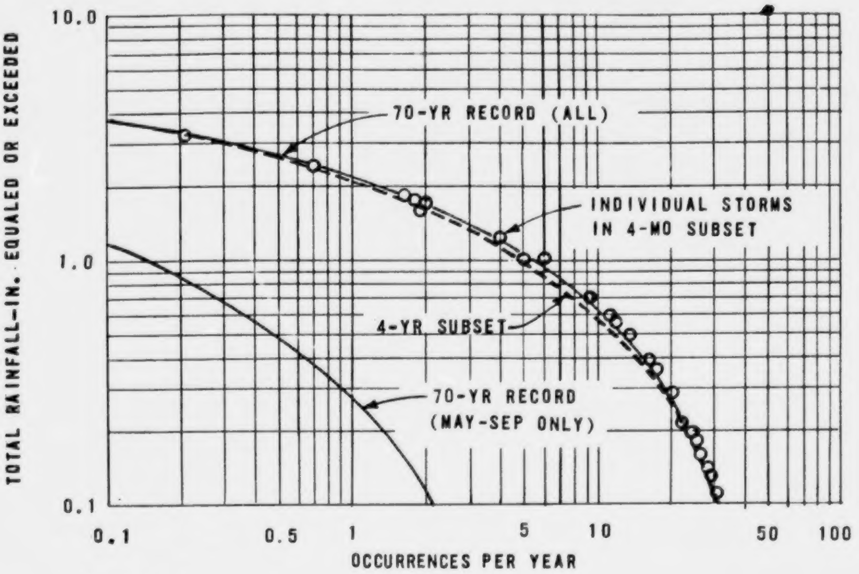


Figure 5. Storm intensity versus frequency [1]



NOTE: in. x 2.54 = cm

Figure 6. Storm magnitude versus frequency [1].

Another analysis using only 1972-1976 data determined ratios that, when applied to the NWS gage, generated representative rainfall conditions in each of the 23 subareas (see Figure 7). Thus each subarea could be run with the 69 years of record. It should be noted that this extrapolation was appropriate only because of the close correlation between the characteristics of the 4-year data set and the 69-year data.

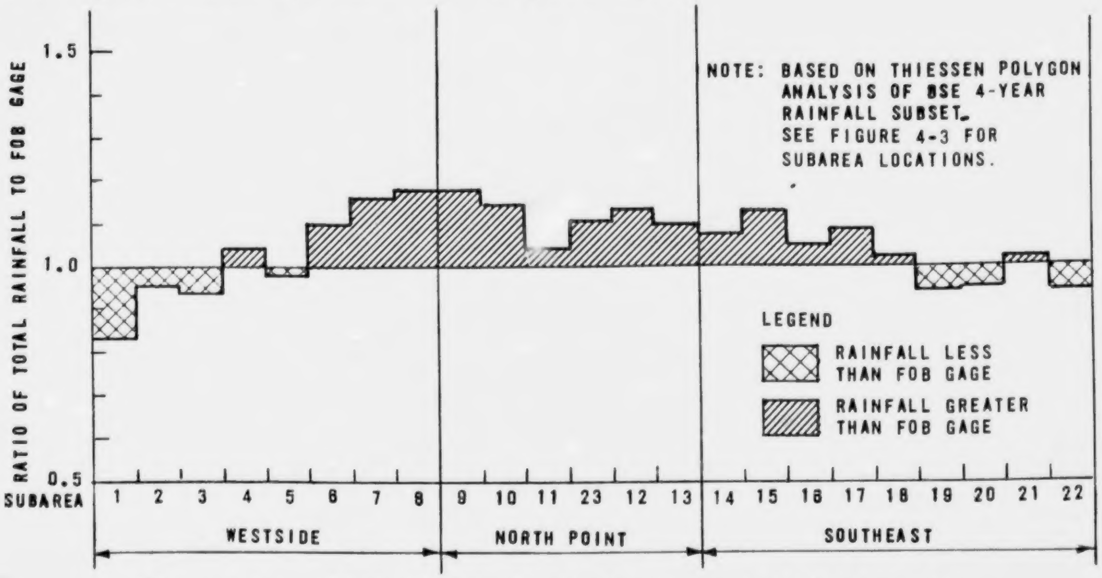


Figure 7. Experienced rainfall variability [1].

During the rainfall analysis, it was discovered that a 4-month subset of the data demonstrated nearly identical characteristics to the 69-year and 4-year subsets. This 4-month subset was used during the production run phase to minimize computer run costs. Different alternative configurations were first tested using the 4-month subset. Promising combinations of storage and pumping for a given alternative were then run on the 4-year subset for confirmation.

Water quality also was determined in this preparatory phase. Dry-weather data were obtained from influent records for the three existing sewage treatment plants. Projected per capita dry-weather loadings were used as input to the model.

Treatment plant influent data for storm days were analyzed to obtain a wet-weather quality characterization. Since the plant records were based on daily composite samples, a sampling program was developed to obtain additional wet-weather characterization data. Representative dry- and wet-weather water quality data used in this application of SFMAC are contained in Tables 5 and 6.

Table 5. TYPICAL WESTSIDE DRY-WEATHER WASTEWATER CHARACTERISTICS [1]

Design basis	
Flow, gal/capita·d	105
Flow, Mgal/d	
Avg dry weather	22
Avg maximum hourly	34
Hourly peak dry weather	47.6
Hourly minimum dry weather	6
Maximum monthly dry weather	24.5
BOD_5	
Avg annual concentration, mg/L	180
Avg annual load, 1,000 lb/d	32.7
Maximum monthly load, 1,000 lb/d	41.3
Suspended solids	
Avg annual concentration, mg/L	170
Avg annual load, 1,000 lb/d	31.0
Maximum monthly load, 1,000 lb/d	35.2

gal/capita·d x 7.785 = L/capita·d
lb x 0.454 = kg
Mgal/d x 0.0438 = m^3/s

Table 6. PROJECTED STORMWATER CHARACTERISTICS [1]

	Drainage area	
	Westside	Bayside (North Shore and Southeast)
Flow		
Avg annual volume, Mgal	2,896	5,174
Maximum monthly volume, Mgal	651	1,163
Peak hourly rate, Mgal/d		
3 month storm	998	2,114
6 month storm	1,273	2,698
1 year storm	1,548	3,281
5 year storm	2,167	4,593
Biochemical oxygen demand (BOD_5)		
Avg annual load, 1,000 lb	1,352	2,416
Maximum monthly load, 1,000 lb	304	543
Peak hourly load, 1,000 lb/h		
3 month storm	23.6	50.0
6 month storm	30.1	63.8
1 year storm	36.6	77.6
5 year storm	51.3	108.6
Suspended solids		
Avg annual load, 1,000 lb	4,034	7,200
Maximum monthly load, 1,000 lb	907	1,618
Peak hourly load, 1,000 lb/h		
3 month storm	62.1	131.6
6 month storm	79.2	167.9
1 year storm	96.4	204.3
5 year storm	134.9	286.0

Note: 3 month storm - storm which occurs an average of 4 times per year

6 month storm - storm which occurs an average of 2 times per year

1 year storm - storm which occurs an average of 1 time per year

5 year storm - storm which occurs an average of once every 5 years.

Mgal x 3,785 = m^3
Mgal/d x 0.0438 = m^3/s
lb x 0.454 = kg

Model Calibration

Calibration of SFMAC involved comparing results from the model with actual storm flow data and an existing city computer model, TREAT IV. All three of the primary watersheds (North Shore, Southeast, and Westside) were used in the study. The calibration effort is summarized here; detailed calibration information is included in Appendix B.

Both wet-weather plant influent and overflow quality data were collected for six storms in the spring and fall of 1977 as part of the sampling program. SFMAC calculated values and actual storm data were compared for flow, biochemical oxygen demand (BOD) and suspended solids (SS) concentrations, and overflow frequency and duration. Statistical analyses developed correlation coefficients ranging from 0.6 to 0.9 for flow, 0.4 to 0.7 for BOD, and 0.3 to 0.5 for SS. However, the nonuniformity and scarcity of the event data limited the effectiveness of the statistical correlation.

The SFMAC comparison with TREAT IV examined wet-weather treatment rate and overflow volume. The model results were shown to be comparable.

Production Runs

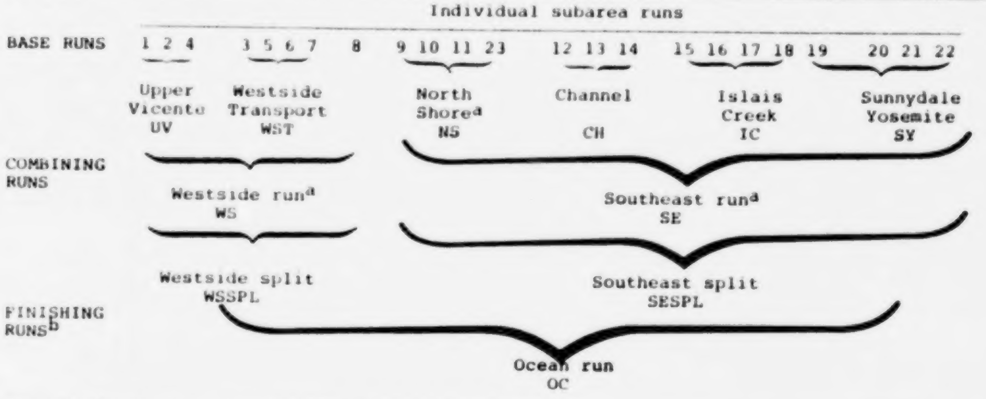
Once preparation and calibration of the model were completed, the final application procedure was to run the model. The production runs in the San Francisco application typically had three phases. The first phase established base runs for each of the watersheds. Next came combination runs which grouped the subareas depending on the alternative chosen. Storage and treatment balances were determined in this second phase. The third stage involved finishing runs for selected alternatives.

The base runs established hourly runoff volume and quality for each watershed. Storage options of SFMAC were not used because the system does not have any storage facilities in individual watersheds. The base runs and output files (one for each subarea) were generated for 69-year, 4-year, and 4-month rainfall data sets. Since dry-weather flow data existed for only the three major watersheds, it was not included in the base runs.

The combination runs constituted the heart of the SFMAC analyses. Depending on the alternative being analyzed, the base runs were selected to conform with the system configuration and flow routing. During this stage, storage and pumping requirements were balanced to obtain the desired overflow frequency. A diagram of the combining runs required in the San Francisco application of SFMAC is shown in Table 7 and explained in the following discussion.

Subarea runoff was lateral inflow during the combining run. If more than four subareas constituted a primary watershed, two levels of combination were necessary. In the example, the North Shore watershed contained subareas 9, 10, 11, and 23. Thus, the lateral inflows, dry-weather quality, and pumping/storage configurations could be included in one combining run. An overflow file and a combined treated file (dry- and wet-weather pumping capacities) were created. Several runs were made at this stage, varying pumping and storage, to arrive at the desired overflow frequency. In this particular alternative, the dry- and wet-weather flow was pumped to a transport line in the Southeast watershed. The North Shore treated file became a new lateral inflow for the Southeast combining run. The flow routing and file names are illustrated in Figure 8.

Table 7. DIAGRAM OF COMPUTER RUNS REQUIRED FOR SAN FRANCISCO APPLICATION OF SFMAC



a. Included dry-weather, storage, and pumping input to model.

b. Plus postprocessor runs not shown in this table for selected output files.

For Southeast, referring to Table 7, it can be seen that several intermediate combination runs were needed to reduce the number of lateral inflows to four or less. Including North Shore, four runs were needed. The final Southeast combining run included dry-weather flow, and storage and pumping configurations. After several runs to pinpoint the storage volume and pumping rates necessary to meet the desired overflow frequency, the two output files generated were the overflow file and the dry- and wet-weather treatment file. SFMAC was applied to the Westside of the city in a similar fashion.

The final phase of the production runs was the finishing run. The finishing run was executed once the desired overflow frequency had been obtained for each of the primary watersheds. The finishing run consisted of (1) separating dry- and wet-weather portions of the treated files, (2) combining wet-weather files that represent flow through the Southwest treatment plant, and (3) analyzing the overflow files.

Until this point, no treatment had been specified for the dry- and wet-weather flows contained in the treated file. By splitting the dry- and wet-weather portion of the treated file, subsequent runs could be made on the files to determine the level of treatment necessary for both cases to meet effluent standards.

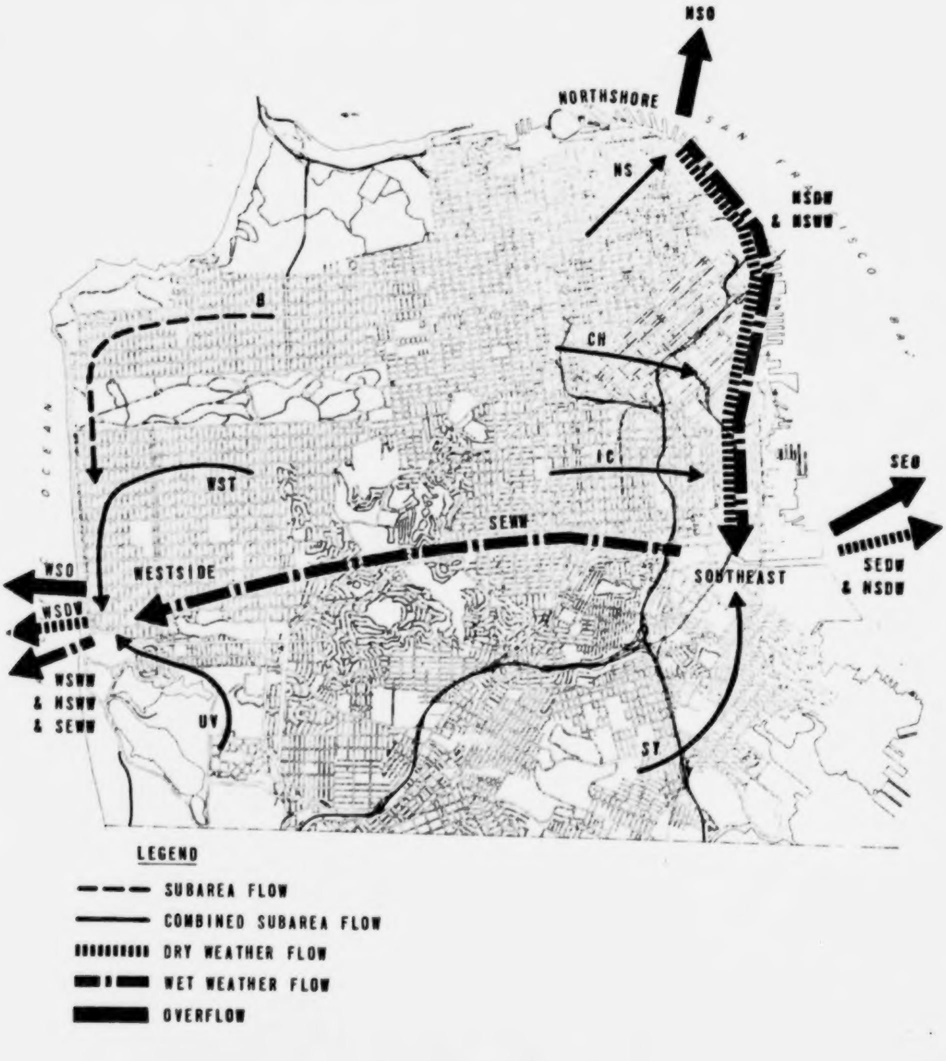


Figure 8. Flow routing diagram.

Dry- and wet-weather portions in the San Francisco sewer system are really determined by pumping rates. This relationship is shown in Figure 9.

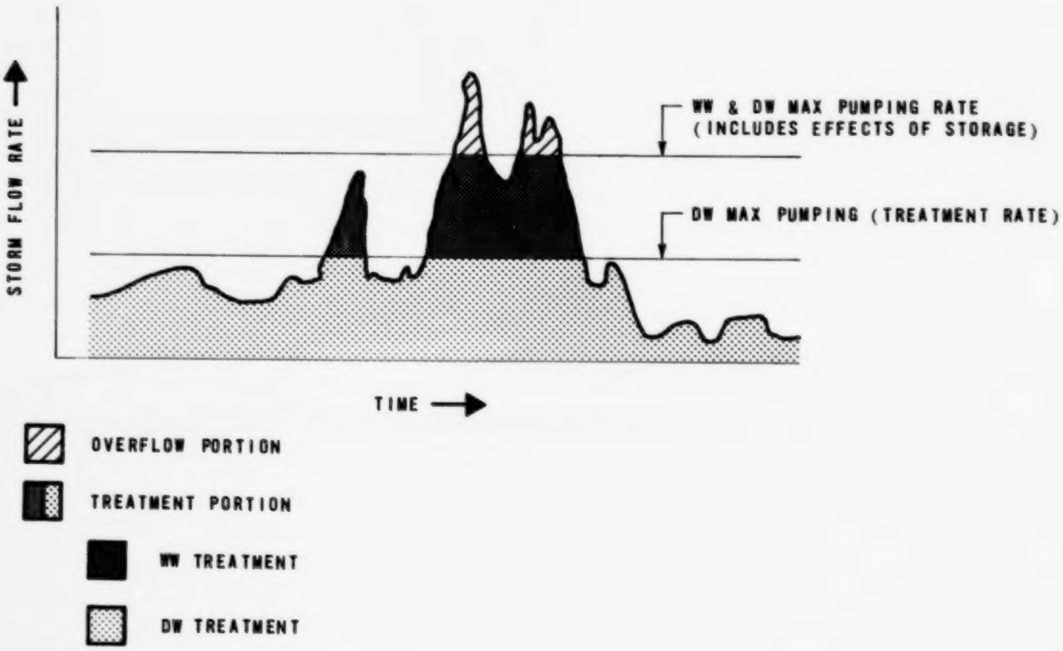


Figure 9. Overflow and dry- and wet-weather flow relationships to pumping rates.

The San Francisco analysis first determined compliance with overflow frequency to know how much flow had to be treated, and then set out to determine the treatment necessary for that flow. In the case of wet weather, since it was to be treated at only one location, an additional SFMAC run combined the wet-weather files to determine the actual flow through the plant.

The last finishing runs used the postprocessor programs to analyze the overflow files and wet-weather plant flow file. The application procedures for the postprocessors are discussed later in this section.

Participation of City Staff

The San Francisco city staff participated in data preparation and output review. The staff was not directly involved with the majority of the production runs, but a training session was held to demonstrate the production process to them. Involvement with data preparation by the staff consisted of supplying city records, and analyzing flow and quality records for dry- and wet-weather conditions. Participation also included checking the chosen numbers to verify they were representative. During production runs, the staff did examine output, and suggested pumping and storage combinations.

The SFMAC training session consisted of a set of combination runs to demonstrate the sequence of the production phase of model application. File handling and iterative procedure of balancing storage and pumping to achieve desired overflow frequency were included in the session.

HISTO POSTPROCESSOR PROGRAM

The postprocessor program HISTO, which produces histogram plots of flow, concentration, and mass loads, was used to evaluate two major aspects of the various master plan alternatives. The first aspect was the frequency and duration of operation of the proposed wet-weather treatment plant. Second, the frequency, volume, and pollutant load of overflows were evaluated.

Plant Operation Frequency

The initial evaluation of each master plan alternative using SFMAC determined the system storage volume and the wet-weather treatment plant size required to meet various allowable overflow frequency limits. Once the storage and treatment capacities were established, it was necessary to estimate the length of time the plant would operate for each storm and the time available between storm events to drain and clean sedimentation tanks and grit chambers before the next storm.

The results of SFMAC were reviewed and a typical year was selected from the 70 years of rainfall record for use in evaluating the plant operation frequency. Using the SFMAC plant flow file, HISTO was run and the hourly plot of time versus flowrate was printed. (It should be noted here that due to the simplifying assumptions associated with SFMAC, the hourly values are not exactly representative of individual storm events but provide general indications of what is to be expected.) The time between storms was determined for each event. Thus, it was possible to determine the number of times the tanks would be clean at the start of a storm and also when the tanks would still contain water or sediment at the start of the next storm event. The sludge storage capacity required within the tanks was selected based on the worst condition when there was insufficient time to clean before the next storm event. A representative chronology of the wet-weather operations and cleanup needs for the proposed San Francisco Southwest Water Pollution Control Plant is shown in Figure 10.

Overflows

The volume and mass load for the overflows was determined using the SFMAC overflow files. Summary tables were prepared by HISTO that showed the number of hours the flows and mass loads exceeded various ranges. This allowed the determination of the frequency that various overflows would occur.

VDAY POSTPROCESSOR PROGRAM

The violation day postprocessor program VDAY was used to determine the effect of the overflows for various storage/treatment capacity options on the receiving water coliform concentration limits. The coliform concentration limits were identified previously in Section 5. Based on the beneficial uses previously established by the Regional Water Quality Control Board (RWQCB) for various reaches of San Francisco Bay, the VDAY program was run using the SFMAC overflow files to estimate the number of coliform violation days.

A cost/benefit analysis was done relating the cost of meeting several specified overflow frequency limitations to the resulting reduction in violation days. The results of the cost/benefit analysis were used as part of a presentation by the city to the RWQCB, which resulted in the relaxation of the overflow frequency allowance and a substantial reduction in the cost of the city's pollution abatement facilities.

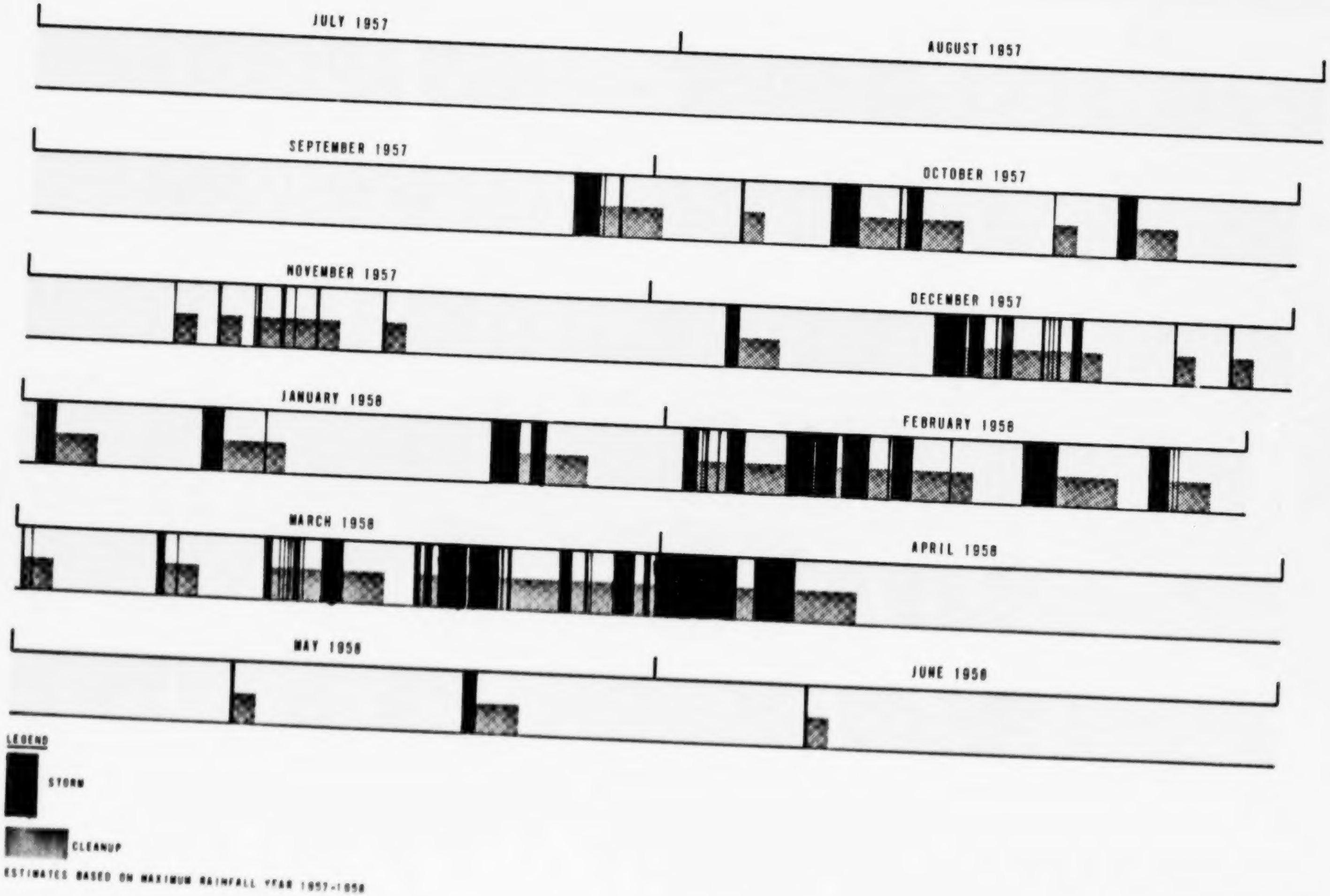


Figure 10. Representative chronology of Southwest WPCP wet-weather operations and cleanup needs [2].

SECTION 7

MODEL RESULTS

The application procedure described in Section 6 was repeated for each alternative examined. The results from the San Francisco analysis are summarized in this section.

LOCAL AND AREAWIDE RESULTS

The results from both individual subareas and combination runs are presented. Wastewater volumes and pollutant loads for existing and future system configurations are also discussed.

Subareas

The data generated by the base runs for each of the 23 subarea watersheds are listed in Table 8. Annual average wet-weather flow, and BOD and SS loads are presented. The percent contribution of flow and area for each subarea is also tabulated. The major watershed totals are shown in Table 9. The subarea quantities are fairly uniform with a range from 2 to 10% of the total contribution. The North Shore area supplies 10% of the total runoff and pollutant loads; Southeast donates 57% of the total; and Westside supplies the remaining 33%.

Major Watersheds

Runoff volumes and pollutants contributed by each subarea were then joined into major watersheds for the existing system. The results are tabulated in Table 10. The system storage and pumping (or treatment) capacities are outlined in Table 11.

Under the existing conditions, approximately 88% of the total wastewater volume is treated. The remaining 12% overflows without treatment to receiving waters. The largest wastewater volume is processed through the Southeast area. The greatest load on receiving waters also is generated from the Southeast. The Westside watershed is the second largest contributor.

Table 8. SUBAREA CLASSIFIED AND SFMAC GENERATED STORMWATER VALUES[a]

Subarea identification	Avg runoff coefficient K[b]	Area, acres	Avg annual load, 1,000 lb		Avg annual stormwater volume, Mgal	Fraction of total area, %	Fraction of total volume, %
			BOD[c]	SS[d]			
01	0.60	538	77	227	160	2.2	1.8
02	0.60	1,011	163	482	344	4.0	3.8
03	0.63	949	150	446	319	3.8	3.5
04	0.63	703	120	360	260	2.8	2.9
05	0.61	562	90	267	190	2.2	2.1
06	0.50	2,759	382	1,163	856	11.0	9.5
07	0.52	601	91	277	205	2.4	2.3
08	0.51	1,990	295	901	666	8.0	7.4
09	0.60	241	41	124	90	1.0	1.0
10	0.70	804	153	465	340	3.2	3.8
11	0.75	772	151	454	326	3.1	3.6
12	0.69	3,235	612	1,862	1,368	12.9	15.2
13	0.73	2,092	395	1,194	871	8.4	9.7
14	0.64	235	39	116	85	0.9	0.9
15	0.60	755	130	393	286	3.0	3.2
16	0.60	800	124	373	272	3.2	3.0
17	0.60	2,753	466	1,387	997	11.0	11.0
18	0.60	1,425	219	652	468	5.7	5.2
19	0.60	62	9	26	18	0.2	0.2
20	0.55	552	76	224	159	2.2	1.8
21	0.60	986	153	453	322	3.9	3.6
22	0.66	798	125	367	261	3.2	2.9
23	0.75	372	73	220	160	1.5	1.8
Total	0.62 (avg)	24,995	4,134	12,433	9,023	100	100

a. Rainfall factor = 1.0, actual rainfall data used.

b. Area weighted averages.

c. BOD concentrations: 1st hour, 136 mg/L; 2nd hour, 71 mg/L; 3rd hour, 32 mg/L.

d. SS concentrations: 1st hour, 281 mg/L; 2nd hour, 214 mg/L; 3rd hour, 127 mg/L.

acre x 0.405 = ha
lb x 0.454 = kg
Mgal x 3,785 = m^3

Table 9. COMBINED WATERSHED STORMWATER CHARACTERISTICS

	Area, acres	Avg runoff coefficient K	Avg annual load, 1,000 lb		Avg annual stormwater volume, Mgal	Fraction of total volume, %
			BOD	SS		
North Shore (areas 9, 10, 11, 23)	2,189	0.72	418	1,263	916	10
Southeast (areas 12-22)	13,693	0.64	2,348	7,047	5,107	57
Westside (areas 1-8)	9,113	0.55	1,368	4,123	3,000	33
Total	24,995	0.62 (avg)	4,134	12,433	9,023	100

acre x 0.405 = ha
lb x 0.454 = kg
Mgal x 3,785 = m^3

Table 10. EXISTING CONDITIONS (71 OVERFLOWS PER YEAR AVERAGE)[a] AVERAGE ANNUAL VALUES

	North Shore	Westside	Southeast
Total wastewater, gal x 10^9	6.9	10.5	35.0
Total treated, %	93.2	80.4	89.7
Total overflowed, %	6.8	19.6	10.3
Total overflow, h	136	300	360
BOD discharged, 1,000 lb			
Overflow	247.7	1,039.9	2,177.0
Dry-weather treated	963.7[b]	9,117.1[c]	5,290.5[b]
Wet-weather treated	--	--	--
SS discharged, 1,000 lb			
Overflow	591.7	2,763.3	5,001.9
Dry-weather treated	921.1[b]	5,528.0[d]	5,180.7[b]
Wet-weather treated	--	--	--

a. Includes contracts under construction.

b. Secondary treatment at 90% removal efficiency.

c. Primary treatment at 30% removal efficiency.

d. Primary treatment at 60% removal efficiency.

gal x 3,785 = L
lb x 0.454 = kg

Table 11. STORAGE AND PUMPING/TREATMENT CAPACITIES

	North Shore	Westside	Southeast
Existing conditions			
Storage, Mgal	8.7	0	26.7
Pumping/treatment, Mgal/d			
Dry weather	30[a]	70[a]	142[b]
Wet weather	--	--	--
Future conditions			
Storage, Mgal	31	41	66
Pumping treatment, Mgal/d			
Dry weather	30	50	142
Wet weather	31	120	280
Overflows, avg No./yr	4	8	8

a. Primary treatment.

b. Secondary treatment.

Mgal x 3,785 = m^3
Mgal/d x 0.0438 = m^3/s

Revised Major Watersheds

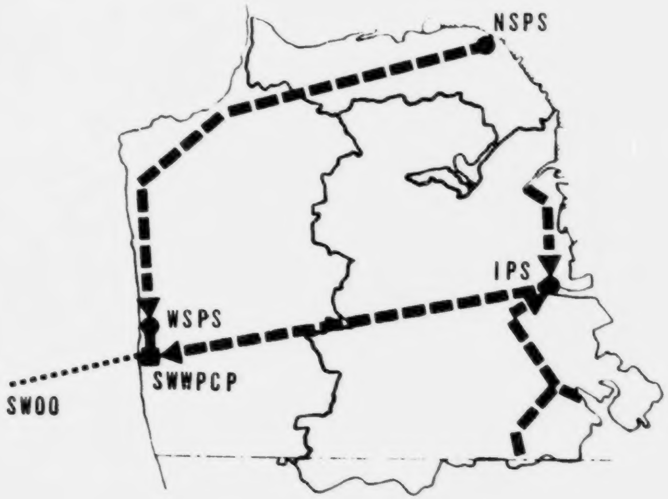
After establishing the existing conditions, the base runs were combined as appropriate for each alternative examined. The alternatives were derived from one of four basic Master Plan routing schemes, shown in Figures 11 to 14.

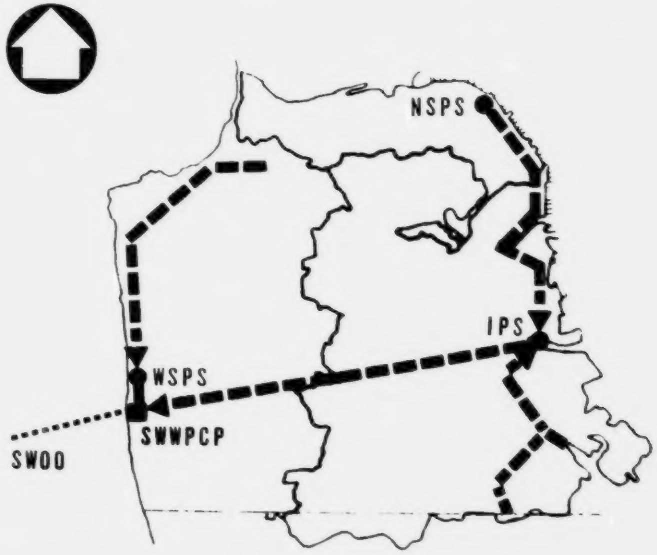
When the number of alternatives had been narrowed to ten, all four Master Plan schemes were represented at differing overflow frequencies. A summary of the wet-weather facilities for the 10 alternatives is presented in Table 12. Of the ten alternatives--selected primarily on a basis of cost and engineering feasibility--five were selected for further detailed study. Schematics of each of the five alternative systems are presented in Figures 15 to 19. The pumping and storage volumes shown are estimates of where required facilities could be located around the city. Storage volumes were determined by the SFMAC runs and then allocated to appropriate watersheds.

Table 12. SUMMARY OF TEN ALTERNATIVES
WET-WEATHER FACILITIES [1]

			Storage volume, Mgal			Pump station capacity, Mgal/d			Treatment plant capacity, Mgal/d		
Alternative	Master Plan	Overflows, No./yr	West-side	North Shore	South-east	West-side	North Shore	Islais Creek	South-west	North Point	Bay-side
1	1A	1	134	31	277	240	88	400	640	--	--
2	1A	4	64	31	114	240	31	400	640	--	--
3	1B	1	119	31	223	240	88	400	640	--	--
4	1B	4	74	31	97	160	31	480	640	--	--
5	2	1	119	31	277	240	88	400	640	88	--
6	2	4	74	31	114	160	31	400	560	31	--
7	3	1	119	31	195	240	88	400	240	88	400
8	3	4	74	31	114	160	31	400	160	31	400
9	1B	8	41	31	66	120	31	280	400	--	--
10	3	8	41	31	60	120	31	320	120	31	320

Mgal x 3,785 = m^3
Mgal/d x 0.0438 = m^3/s





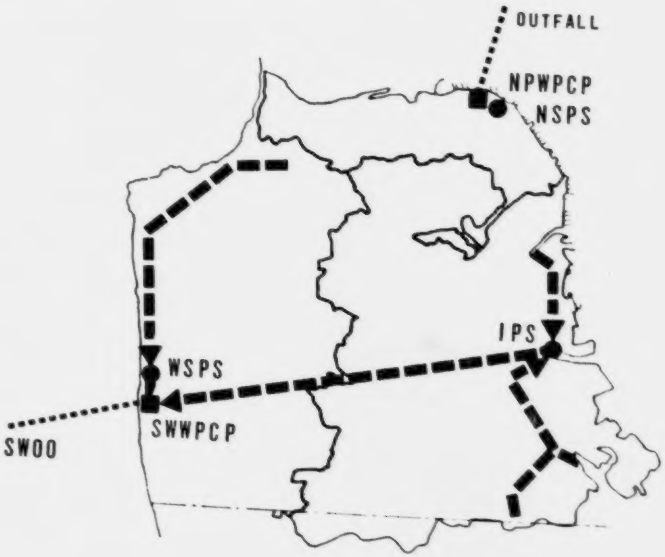
LEGEND

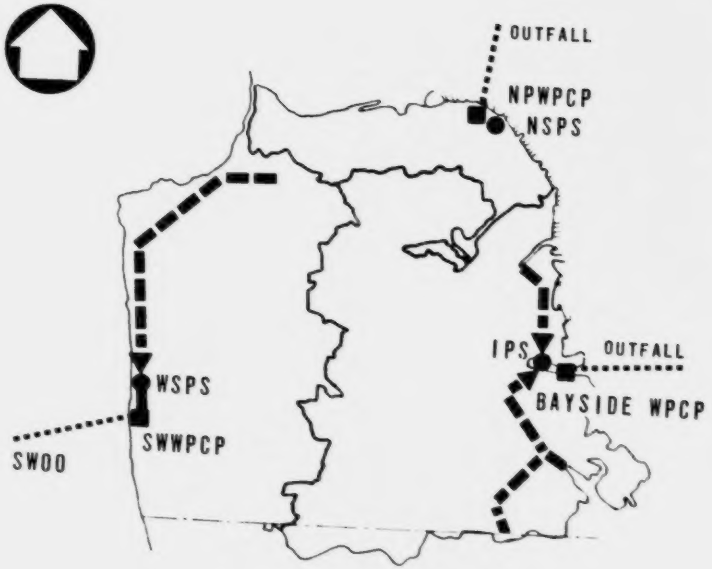
▬ ▬	WET-WEATHER FLOW ROUTES
●	PUMP STATION
■	TREATMENT PLANT
······	OUTFALL

NSPS	NORTH SHORE PUMPING STATION
IPS	ISLAIS PUMPING STATION
WSPS	WESTSIDE PUMPING STATION
SWWPCP	SOUTHWEST WATER POLLUTION CONTROL PLANT
SWOO	SOUTHWEST OCEAN OUTFALL

Figure 11. Wet-weather Master Plan 1A, dual crossing [1].

Figure 12. Wet-weather Master Plan 1B, low level bayside [1].





LEGEND

- ▬ ▬ WET-WEATHER FLOW ROUTES
- ● PUMP STATION
- ■ TREATMENT PLANT
- ⋯⋯ OUTFALL

NSPS NORTH SHORE PUMPING STATION
IPS ISLAIS PUMPING STATION
WSPS WESTSIDE PUMPING STATION
SWWPCP SOUTHWEST WATER POLLUTION CONTROL PLANT
SWOO SOUTHWEST OCEAN OUTFALL

Figure 13. Wet-weather Master Plan 2, modified ocean discharge [1].

Figure 14. Wet-weather Master Plan 3, bay and ocean discharge [1].

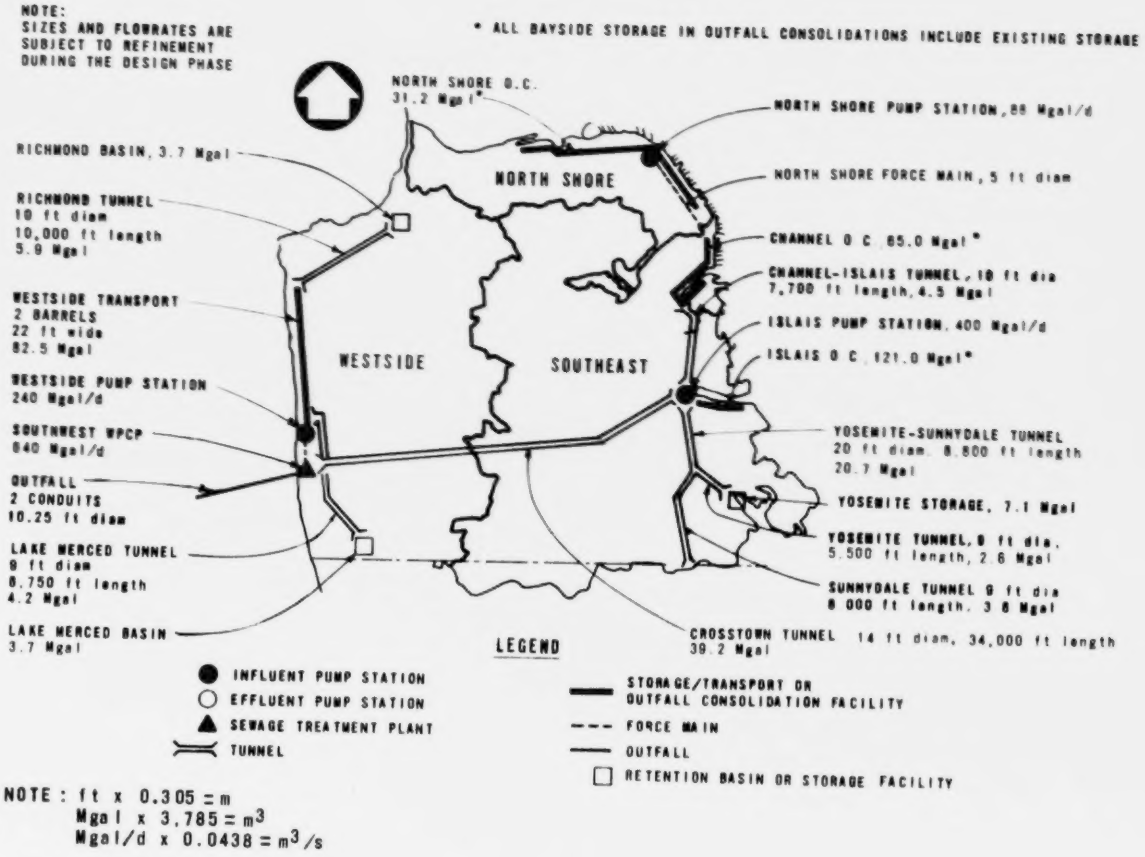
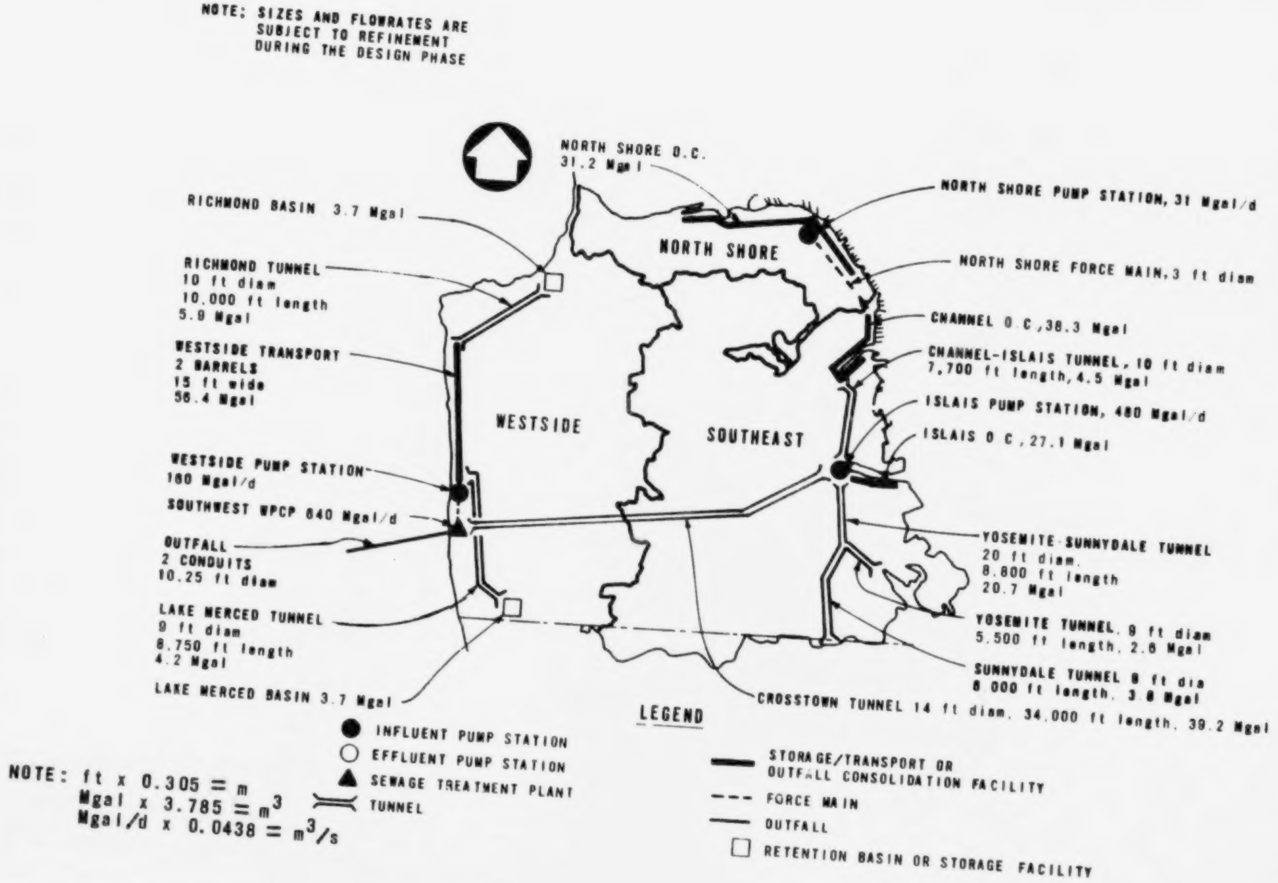

NOTE:
SIZES AND FLOWRATES ARE SUBJECT TO REFINEMENT DURING THE DESIGN PHASE
* ALL BAYSIDE STORAGE IN OUTFALL CONSOLIDATIONS INCLUDE EXISTING STORAGE
NORTH SHORE O.C. 31.2 Mgal*
NORTH SHORE PUMP STATION, 88 Mgal/d
NORTH SHORE FORCE MAIN, 5 ft diam
CHANNEL O.C. 65.0 Mgal*
CHANNEL-ISLAIS TUNNEL, 10 ft dia 7,700 ft length, 4.5 Mgal
ISLAIS PUMP STATION, 400 Mgal/d
ISLAIS O.C. 121.0 Mgal*
YOSEMITE-SUNNYDALE TUNNEL 20 ft diam. 8,800 ft length 20.7 Mgal
YOSEMITE STORAGE, 7.1 Mgal
YOSEMITE TUNNEL, 8 ft dia. 5,500 ft length, 2.6 Mgal
SUNNYDALE TUNNEL 9 ft dia 8,000 ft length, 3.8 Mgal
CROSSTOWN TUNNEL 14 ft diam, 34,000 ft length 39.2 Mgal
RICHMOND BASIN, 3.7 Mgal
RICHMOND TUNNEL 10 ft diam 10,000 ft length 5.9 Mgal
WESTSIDE TRANSPORT 2 BARRELS 22 ft wide 82.5 Mgal
WESTSIDE PUMP STATION 240 Mgal/d
SOUTHWEST WPCP 840 Mgal/d
OUTFALL 2 CONDUITS 10.25 ft diam
LAKE MERCED TUNNEL 9 ft diam 8,750 ft length 4.2 Mgal
LAKE MERCED BASIN 3.7 Mgal
NORTH SHORE
WESTSIDE
SOUTHEAST
LEGEND
● INFLUENT PUMP STATION
○ EFFLUENT PUMP STATION
▲ SEWAGE TREATMENT PLANT
TUNNEL
STORAGE/TRANSPORT OR OUTFALL CONSOLIDATION FACILITY
FORCE MAIN
OUTFALL
☐ RETENTION BASIN OR STORAGE FACILITY
NOTE: ft x 0.305 = m
Mgal x 3,785 = m³
Mgal/d x 0.0438 = m³/s

Figure 15. Schematic of wastewater management system - Alternative 3 (Master Plan 1B, 1 overflow per year) [1].



NOTE: SIZES AND FLOWRATES ARE SUBJECT TO REFINEMENT DURING THE DESIGN PHASE
NORTH SHORE O.C. 31.2 Mgal
NORTH SHORE PUMP STATION, 31 Mgal/d
RICHMOND BASIN 3.7 Mgal
NORTH SHORE
NORTH SHORE FORCE MAIN, 3 ft diam
RICHMOND TUNNEL 10 ft diam 10,000 ft length 5.9 Mgal
CHANNEL O.C., 38.3 Mgal
WESTSIDE TRANSPORT 2 BARRELS 15 ft wide 56.4 Mgal
CHANNEL-ISLAIS TUNNEL, 10 ft diam 7,700 ft length, 4.5 Mgal
ISLAIS PUMP STATION, 480 Mgal/d
WESTSIDE
SOUTHEAST
ISLAIS O.C., 27.1 Mgal
WESTSIDE PUMP STATION 160 Mgal/d
SOUTHWEST WPCP 640 Mgal/d
OUTFALL 2 CONDUITS 10.25 ft diam
YOSEMITE-SUNNYDALE TUNNEL 20 ft diam. 8,800 ft length 20.7 Mgal
LAKE MERCED TUNNEL 9 ft diam 8,750 ft length 4.2 Mgal
YOSEMITE TUNNEL, 9 ft diam 5,500 ft length, 2.6 Mgal
SUNNYDALE TUNNEL 9 ft dia 8,000 ft length, 3.8 Mgal
LAKE MERCED BASIN 3.7 Mgal
CROSSTOWN TUNNEL 14 ft diam, 34,000 ft length, 39.2 Mgal
LEGEND
● INFLUENT PUMP STATION
○ EFFLUENT PUMP STATION
▲ SEWAGE TREATMENT PLANT
TUNNEL
STORAGE/TRANSPORT OR OUTFALL CONSOLIDATION FACILITY
FORCE MAIN
OUTFALL
☐ RETENTION BASIN OR STORAGE FACILITY
NOTE: ft x 0.305 = m
Mgal x 3.785 = m3
Mgal/d x 0.0438 = m3/s

Figure 16. Schematic of wastewater management system - Alternative 4 (Master Plan 1B, 4 overflows per year) [1].

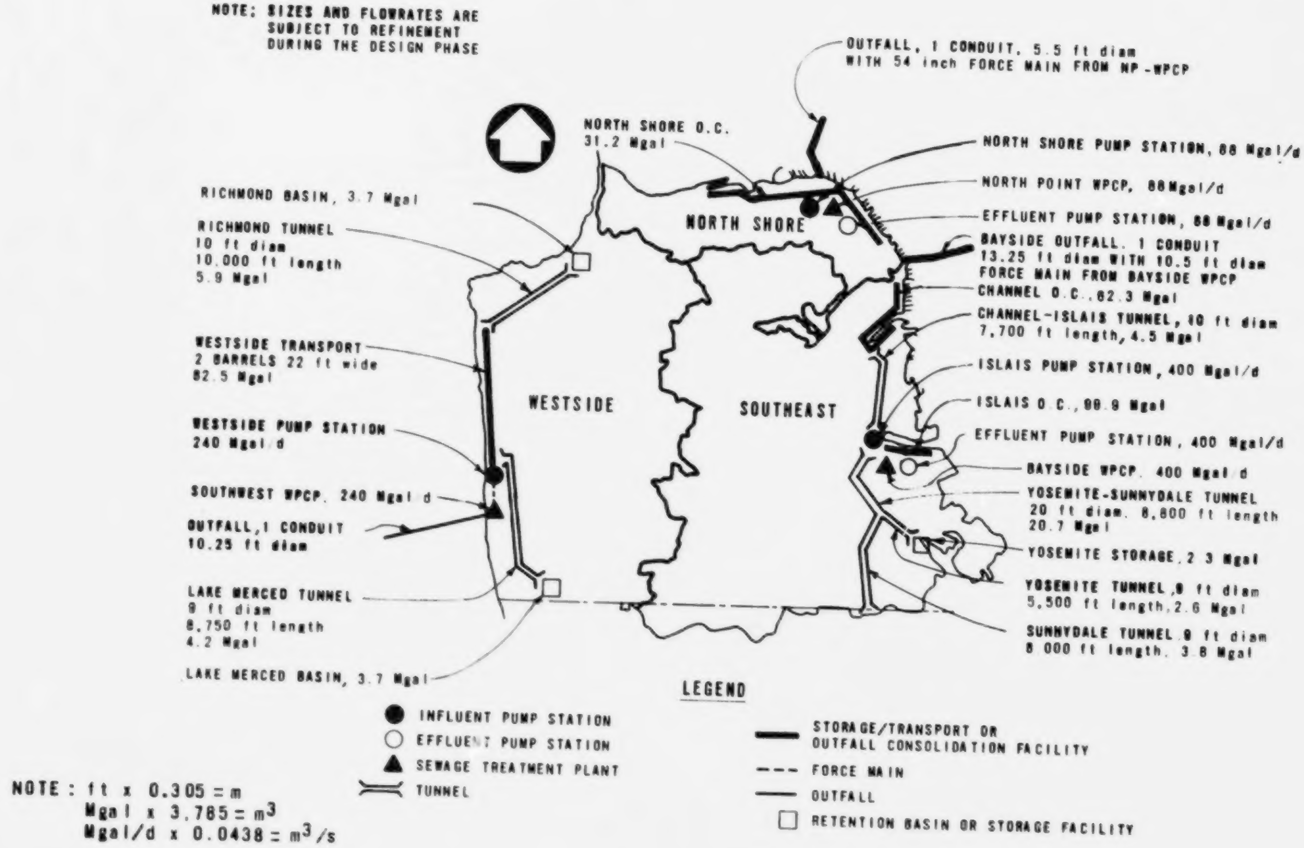

NOTE: SIZES AND FLOWRATES ARE SUBJECT TO REFINEMENT DURING THE DESIGN PHASE
OUTFALL, 1 CONDUIT, 5.5 ft diam WITH 54 inch FORCE MAIN FROM NP-WPCP
NORTH SHORE O.C. 31.2 Mgal
NORTH SHORE PUMP STATION, 88 Mgal/d
NORTH POINT WPCP, 88Mgal/d
EFFLUENT PUMP STATION, 88 Mgal/d
BAYSIDE OUTFALL. 1 CONDUIT 13.25 ft diam WITH 10.5 ft diam FORCE MAIN FROM BAYSIDE WPCP
CHANNEL O.C., 62.3 Mgal
CHANNEL-ISLAIS TUNNEL, 10 ft diam 7,700 ft length, 4.5 Mgal
ISLAIS PUMP STATION, 400 Mgal/d
ISLAIS O.C., 99.9 Mgal
EFFLUENT PUMP STATION, 400 Mgal/d
BAYSIDE WPCP, 400 Mgal/d
YOSEMITE-SUNNYDALE TUNNEL 20 ft diam. 8,800 ft length 20.7 Mgal
YOSEMITE STORAGE, 2.3 Mgal
YOSEMITE TUNNEL, 9 ft diam 5,500 ft length, 2.6 Mgal
SUNNYDALE TUNNEL 9 ft diam 8 000 ft length, 3.8 Mgal
RICHMOND BASIN, 3.7 Mgal
RICHMOND TUNNEL 10 ft diam 10,000 ft length 5.9 Mgal
WESTSIDE TRANSPORT 2 BARRELS 22 ft wide 82.5 Mgal
WESTSIDE PUMP STATION 240 Mgal/d
SOUTHWEST WPCP, 240 Mgal/d
OUTFALL, 1 CONDUIT 10.25 ft diam
LAKE MERCED TUNNEL 9 ft diam 8,750 ft length 4.2 Mgal
LAKE MERCED BASIN, 3.7 Mgal
NORTH SHORE
WESTSIDE
SOUTHEAST
LEGEND
● INFLUENT PUMP STATION
○ EFFLUENT PUMP STATION
▲ SEWAGE TREATMENT PLANT
TUNNEL
STORAGE/TRANSPORT OR OUTFALL CONSOLIDATION FACILITY
--- FORCE MAIN
— OUTFALL
☐ RETENTION BASIN OR STORAGE FACILITY
NOTE: ft x 0.305 = m
Mgal x 3.785 = m3
Mgal/d x 0.0438 = m3/s

Figure 17. Schematic of wastewater management system - Alternative 7 (Master Plan 3, 1 overflow per year) [1].

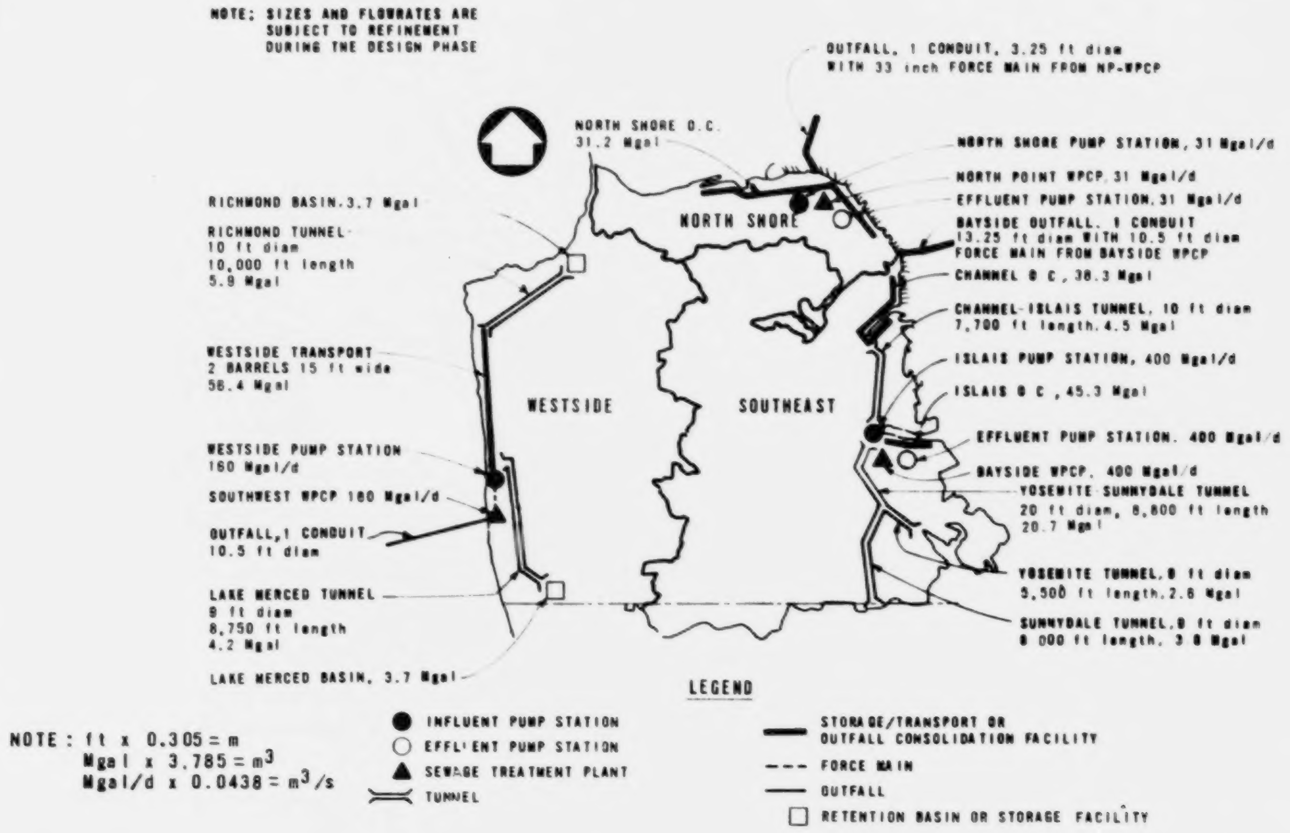

NOTE: SIZES AND FLOWRATES ARE SUBJECT TO REFINEMENT DURING THE DESIGN PHASE
OUTFALL, 1 CONDUIT, 3.25 ft diam WITH 33 inch FORCE MAIN FROM NP-WPCP
NORTH SHORE O.C. 31.2 Mgal
NORTH SHORE PUMP STATION, 31 Mgal/d
NORTH POINT WPCP, 31 Mgal/d
EFFLUENT PUMP STATION, 31 Mgal/d
BAYSIDE OUTFALL, 1 CONDUIT 13.25 ft diam WITH 10.5 ft diam FORCE MAIN FROM BAYSIDE WPCP
CHANNEL O.C., 38.3 Mgal
CHANNEL-ISLAIS TUNNEL, 10 ft diam 7,700 ft length, 4.5 Mgal
ISLAIS PUMP STATION, 400 Mgal/d
ISLAIS O.C., 45.3 Mgal
EFFLUENT PUMP STATION, 400 Mgal/d
BAYSIDE WPCP, 400 Mgal/d
YOSEMITE-SUNNYDALE TUNNEL 20 ft diam, 8,800 ft length 20.7 Mgal
YOSEMITE TUNNEL, 8 ft diam 5,500 ft length, 2.6 Mgal
SUNNYDALE TUNNEL, 8 ft diam 8,000 ft length, 3.8 Mgal
RICHMOND BASIN, 3.7 Mgal
RICHMOND TUNNEL 10 ft diam 10,000 ft length 5.9 Mgal
WESTSIDE TRANSPORT 2 BARRELS 15 ft wide 58.4 Mgal
WESTSIDE PUMP STATION 160 Mgal/d
SOUTHWEST WPCP 160 Mgal/d
OUTFALL, 1 CONDUIT 10.5 ft diam
LAKE MERCED TUNNEL 9 ft diam 8,750 ft length 4.2 Mgal
LAKE MERCED BASIN, 3.7 Mgal
NORTH SHORE
WESTSIDE
SOUTHEAST
LEGEND
● INFLUENT PUMP STATION
○ EFFLUENT PUMP STATION
▲ SEWAGE TREATMENT PLANT
TUNNEL
STORAGE/TRANSPORT OR OUTFALL CONSOLIDATION FACILITY
FORCE MAIN
OUTFALL
☐ RETENTION BASIN OR STORAGE FACILITY
NOTE: ft x 0.305 = m
Mgal x 3.785 = m³
Mgal/d x 0.0438 = m³/s

Figure 18. Schematic of wastewater management system - Alternative 8 (Master Plan 3, 4 overflows per year) [1].

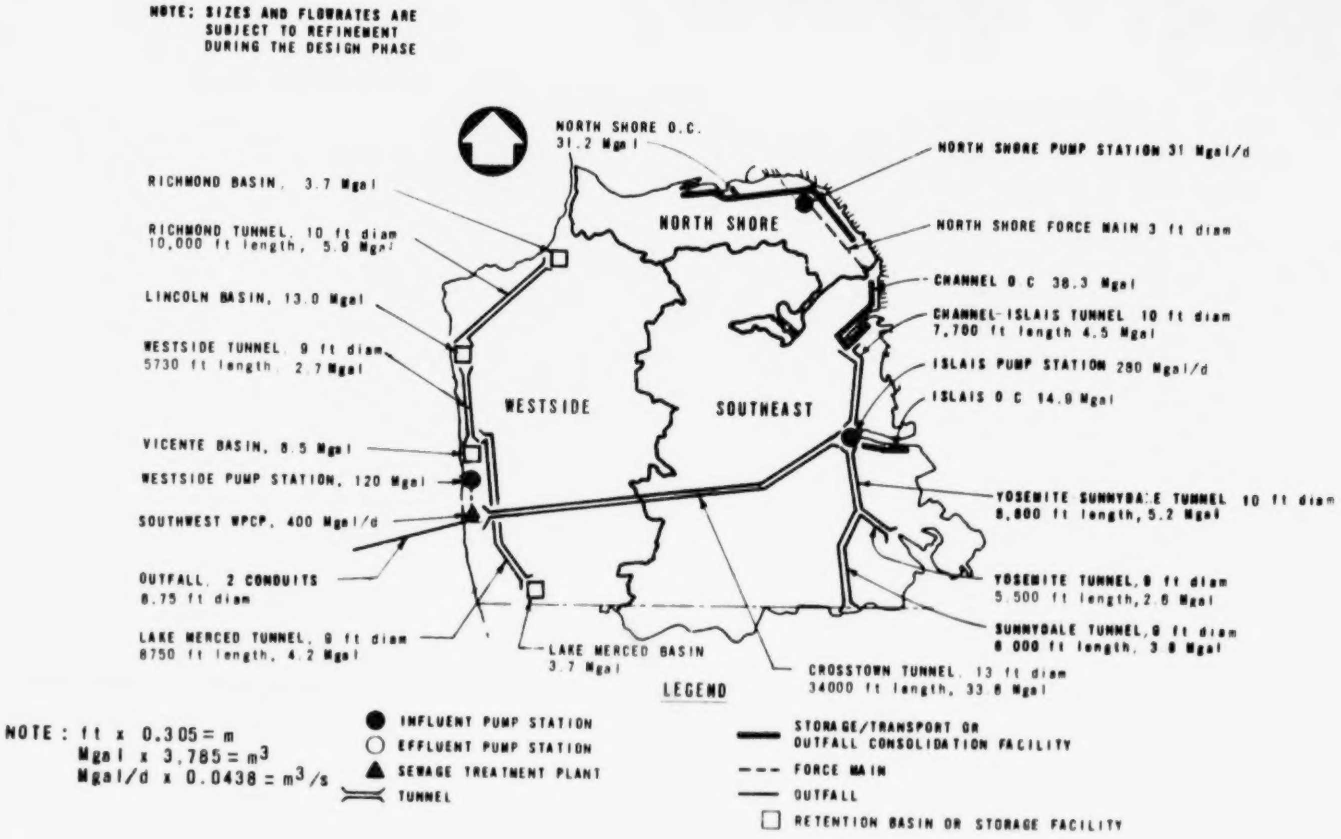

NOTE: SIZES AND FLOWRATES ARE SUBJECT TO REFINEMENT DURING THE DESIGN PHASE
NORTH SHORE O.C. 31.2 Mgal
NORTH SHORE PUMP STATION 31 Mgal/d
RICHMOND BASIN, 3.7 Mgal
NORTH SHORE
NORTH SHORE FORCE MAIN 3 ft diam
RICHMOND TUNNEL, 10 ft diam 10,000 ft length, 5.9 Mgal
CHANNEL O.C 38.3 Mgal
LINCOLN BASIN, 13.0 Mgal
CHANNEL-ISLAIS TUNNEL 10 ft diam 7,700 ft length 4.5 Mgal
WESTSIDE TUNNEL, 9 ft diam 5730 ft length, 2.7 Mgal
ISLAIS PUMP STATION 280 Mgal/d
WESTSIDE
SOUTHEAST
ISLAIS O.C 14.9 Mgal
VICENTE BASIN, 8.5 Mgal
WESTSIDE PUMP STATION, 120 Mgal
YOSEMITE SUNNYDALE TUNNEL 10 ft diam 8,800 ft length, 5.2 Mgal
SOUTHWEST WPCP, 400 Mgal/d
OUTFALL, 2 CONDUITS 8.75 ft diam
YOSEMITE TUNNEL, 9 ft diam 5,500 ft length, 2.6 Mgal
SUNNYDALE TUNNEL, 9 ft diam 8,000 ft length, 3.8 Mgal
LAKE MERCED TUNNEL, 9 ft diam 8750 ft length, 4.2 Mgal
LAKE MERCED BASIN 3.7 Mgal
CROSSTOWN TUNNEL, 13 ft diam 34000 ft length, 33.8 Mgal
LEGEND
● INFLUENT PUMP STATION
○ EFFLUENT PUMP STATION
▲ SEWAGE TREATMENT PLANT
TUNNEL
STORAGE/TRANSPORT OR OUTFALL CONSOLIDATION FACILITY
FORCE MAIN
OUTFALL
☐ RETENTION BASIN OR STORAGE FACILITY
NOTE: ft x 0.305 = m
Mgal x 3.785 = m3
Mgal/d x 0.0438 = m3/s

Figure 19. Schematic of wastewater management system - Alternative 9 (Master Plan 1B, 8 overflows per year) [1].

The SFMAC results for the five alternatives are presented in Tables 13, 14, and 15. The No Project or existing condition alternative is included for comparison. The total wastewater volume treated ranges from 80 to 93% at the existing condition level to 99.6 to 99.8% at the highest treatment level. The selected apparent best alternative is presented in Table 16 and represents a blend of Alternatives 4 and 9 [1].

Table 13. SUMMARY OF SFMAC RESULTS, NORTH SHORE AREA

	1-overflow Alternatives		4-overflow Alternatives		71-overflow No Project Alternative
	3	7	4	8	
Total wastewater, gal x 10^9	479	479	479	479	479
Total treated, %	99.8	99.8	99.0	99.0	93.2
Total overflowed, %	0.2	0.2	1.0	1.0	6.8
Total overflow time, h	208	208	1,152	1,152	9,366
BOD discharged, 1,000 lb					
Overflow	323	323	1,975	1,975	17,091
Dry-weather treated[a]	65,040	65,040	65,028	65,028	66,499
Wet-weather treated	15,679	15,679	14,912	14,912	0
SS discharged, 1,000 lb					
Overflow	1,040	1,040	5,576	5,576	40,830
Dry-weather treated[a]	60,755	60,755	61,600	61,600	63,560
Wet-weather treated	12,211	12,211	9,875	9,875	0
Treatment operations					
Flow, % of treated					
Wet-weather plant	10.4	10.4	8.4	8.4	0
Dry-weather plant	89.6	89.6	91.6	91.6	100
BOD, % of treated					
Wet-weather plant	4.6	4.6	4.4	4.4	0
Dry-weather plant	95.4	95.4	95.6	95.6	100
SS, % of treated					
Wet-weather plant	10.0	10.0	82.0	82.0	0
Dry-weather plant	90.0	90.0	91.8	91.8	100

a. Secondary dry-weather treatment at 90% efficiency.

gal x 3,785 = L
lb x 0.454 = kg

Table 14. SUMMARY OF SFMAC RESULTS, SOUTHEAST AREA

	1-overflow Alternatives		4-overflow Alternatives		8-overflow Alternative	71-overflow No Project Alternative
	3	7	4	8	9	
Total wastewater, gal x 10^9	2,446	2,396	2,442	2,402	2,442	2,414
Total treated, %	99.7	99.8	99.5	99.5	97.6	89.7
Total overflowed, %	0.3	0.2	0.5	0.5	2.4	10.3
Total overflow time, h	280	234	717	684	2,485	24,892
BOD discharged, 1,000 lb						
Overflow	2,468	2,029	6,486	6,228	23,965	150,210
Dry-weather treated[a]	(359,318)	359,432	(360,983)	359,530	(360,383)	365,043
Wet-weather treated	(110,630)	94,601	(99,472)	91,952	(93,861)	0
SS discharged, 1,000 lb						
Overflow	7,697	6,529	20,392	19,549	69,064	345,143
Dry-weather treated[a]	(348,687)	347,939	(350,538)	348,556	(350,841)	357,470
Wet-weather treated	(83,710)	73,057	(77,277)	71,122	(67,971)	--
Treatment operations						
Flow, % of treated						
Wet-weather plant	13.6	12.0	12.5	11.7	11.0	0
Dry-weather plant	86.4	88.0	87.5	88.3	89.0	100
BOD, % of treated						
Wet-weather plant	5.8	5.0	5.2	4.9	5.0	0
Dry-weather plant	94.2	95.0	94.8	95.1	95.0	100
SS, % of treated						
Wet-weather plant	11.8	10.4	10.9	10.2	9.7	0
Dry-weather plant	88.2	89.6	89.1	89.8	90.3	100

a. Secondary dry-weather treatment at 90% efficiency.

Note: ( ) = discharged to ocean.

gal x 3,785 = L
lb x 0.454 = kg

Table 15. SUMMARY OF SFMAC RESULTS, WESTSIDE AREA

	1-overflow Alternatives		4-overflow Alternatives		8-overflow Alternative	71-overflow No Project Alternative
	3	7	4	8	9	
Total wastewater, gal x 10^9	727	727	727	727	727	727
Total treated, %	99.6	99.6	98.4	98.4	95.7	80.4
Total overflowed, %	0.4	0.4	1.6	1.6	4.3	19.6
Total overflow time, h	242	242	981	981	2,715	20,732
BOD discharged, 1,000 lb						
Overflow	948	948	3,916	3,916	11,464	71,753
Dry-weather treated	88,396	88,396	88,330	88,330	88,396	629,080
Wet-weather treated	42,764	42,764	41,608	41,608	37,507	0
SS discharged, 1,000 lb						
Overflow	3,316	3,316	13,034	13,034	36,406	190,666
Dry-weather treated	92,814	92,814	93,207	93,207	93,448	381,431
Wet-weather treated	38,302	38,302	35,844	35,844	31,204	0
Treatment operations						
Flow, % of treated						
Wet-weather plant	21.5	21.5	20.1	20.1	17.7	0
Dry-weather plant	78.5	78.5	79.9	79.9	82.3	100
BOD, % treated						
Wet-weather plant	8.8	8.8	8.6	8.6	7.8	0
Dry-weather plant	91.2	91.2	91.4	91.4	92.2	100
SS, % treated						
Wet-weather plant	18.7	18.7	17.6	17.6	15.6	0
Dry-weather plant	81.3	813.	82.4	82.4	84.4	100

gal x 3.785 = L
lb x 0.454 = kg

Table 16. APPARENT BEST ALTERNATIVE (COMBINATION OF ALTERNATIVES 4 and 9), AVERAGE ANNUAL VALUES

	North Shore	Westside	Southeast
Avg No. of overflows per year	4	8	8
Total wastewater, gal x 10^9	6.9	10.5	35.4
Total treated, %	99.0	95.7	97.6
Total overflowed, %	1.0	4.3	2.4
Total overflow time, h	16.7	39.3	36.0
BOD discharged, 1,000 lb			
Overflow	28.6	166.1	347.3
Dry-weather treated	942.4[a]	1,281.1[b]	5,222.9[a]
Wet-weather treated	216.1	543.6	1,360.3
SS discharged, 1,000 lb			
Overflow	80.8	527.6	1,000.9
Dry-weather treated	892.8[a]	1,354.3[c]	5,084.7[a]
Wet-weather treated	143.1	452.2	985.1
Treatment operations			
Flow, % of treated			
Dry-weather plant	91.6	82.3	89.0
Wet-weather plant	8.4	17.7	11.0
BOD, % of treated			
Dry-weather plant	95.6[d]	92.2	95.0
Wet-weather plant	4.4	7.8	5.0
SS, % of treated			
Dry-weather plant	91.8	84.4	90.3
Wet-weather plant	8.2	15.6	9.7

[a] Secondary treatment at 90% removal efficiency.

[b] Primary treatment at 30% removal efficiency.

[c] Primary treatment at 60% removal efficiency.

gal x 3,785 = L
lb x 0.454 = kg

ASSESSMENT OF POLLUTANT LOADS

Analysis of the results presented in the previous section yields several observations. The cost difference between Master Plan 1B (Figure 9) and Master Plan 3 (Figure 11) configurations for a given overflow frequency were small, about 4%. The cost difference between overflow frequencies, however, was 12 to 14%. The pollutant loads for the various overflow frequencies are listed in Table 17. When compared with the No Project alternative (71 overflow per year), an overflow frequency of eight per year represented a 47% removal of SS load on receiving waters; four overflows per year--51% removal; and one overflow per year--53% removal. BOD loadings show a similar pattern.

Table 17. POLLUTANT LOADS - 69-YEAR TOTALS
1,000 lbs

	Average overflows per year			71-overflow No Project Alternative
	1	4	8	
SS				
North Shore	74,006	77,051	77,051	104,390
Southeast	440,094	448,207	487,876	702,604
Westside	134,432	144,085	161,058	572,097
	648,532	669,343	725,985	1,379,091
Removal, %	53	51	47	--
Incremental % change		3	8	47
BOD				
North Shore	81,042	81,915	81,915	83,590
Southeast	456,062	466,941	478,209	515,253
Westside	132,108	133,854	137,367	700,833
	669,212	682,710	697,491	1,299,676
Removal, %	49	47	46	--
Incremental % change		2	2	46

lb x 0.454 = kg

Examination of the loads also yields the relationship between Master Plans on loading to the bay versus ocean waters. Results are shown in Table 18. Master 1B would discharge 90 to 99% of pollutant load to the ocean; whereas, Master Plan 3 would place 78 to 80% of the pollutants in bay waters.

Table 18. POLLUTANT ALLOCATION TO RECEIVING WATERS 69-YEAR TOTALS

	1-overflow Alternatives		4-overflow Alternatives		8-overflow Alternatives		71-overflow No Project Alternative
	3	7	4	8	9	10	
SS load, 1,000 lb							
Ocean	639,795	134,432	643,375	144,085	651,345	161,058	572,097
Bay	8,737	514,100	25,968	525,258	74,640	564,927	806,994
Total	648,532	648,532	669,343	669,343	725,985	725,985	1,379,091
Ocean, %	99	21	96	22	90	22	41
Bay, %	1	79	4	78	10	78	59
BOD load, 1,000 lb							
Ocean	666,860	132,108	674,249	133,854	671,551	137,367	700,833
Bay	2,352	537,104	8,461	548,856	25,940	560,124	598,843
Total	669,212	669,212	682,710	682,710	697,491	697,491	1,299,676
Ocean %	99.6	20	99	20	96	20	54
Bay, %	0.4	80	1	80	4	80	46

lb x 0.454 = kg

EVALUATION OF ALTERNATIVE MITIGATION MEASURES

A major issue examined in evaluating mitigation measures is the storage-treatment balancing. The ocean versus bay disposal was a second issue addressed. Both issues are discussed next.

Storage-Treatment Balance

During the combination run fine tuning phase of SFMAC application, pumping and storage capacities were adjusted to obtain a specific overflow frequency. There was some flexibility in the final choice since several pairs of capacities will give the same average overflow frequency. As an example, it was found that either a pumping rate of 120 Mgal/d (5.3 m^3/s) and a storage volume of 41.7 Mgal (157,800 m^3) or a pumping rate of 80 Mgal/d (3.5 m^3/s) and a storage volume of 57.3 Mgal (216,900 m^3) for the Westside area would result in an overflow frequency of eight per year. The final choice must be made based on optimization of annual costs, environmental constraints, and other factors.

The different alternatives did not show much influence on the amount of time the wet-weather facilities operate. Comparing results for overflows, only a 4 to 6% in variation in plant operation hours was observed.

System Configuration

The major mitigation measure analyzed was the use of different flow routing configurations to take advantage of ocean and bay assimilative capacities. Studies of tidal currents and flushing ability determine that the bay waters off the Eastside of San Francisco have less available dilution water and assimilative capacity than the Westside. Discharges in the North Shore area would be substantially better than Eastside, but still less favored than an offshore ocean discharge.

The three-plant system has a discharge in all three major watersheds, whereas the one-plant system only discharges off the Westside of the city into the ocean. The impacts on receiving waters were weighed in comparing the alternatives.

INTERFACING WITH RECEIVING WATER IMPACTS

Physical studies estimated the assimilative capacity of receiving waters. The VDAY postprocessor enables a more specific analysis on receiving water impacts. The violation day data together with overflow frequency level costs and pollutant loads provided a basis for a benefit-cost analysis. Comparing the incremental costs for violation day reductions with the overflow frequency resulted in an incremental cost increase when the overflow frequency was reduced to less than eight per year.

SECTION 8

MODEL EFFECTIVENESS

This section discusses the effectiveness of SFMAC in meeting planning objectives, the ease of using SFMAC results, and the acceptance of the model.

EVALUATION

Adequacy for Program Objectives

The use of SFMAC met the planning objectives of examining a large number of alternatives at a technical level sufficient to determine differences in the water quality effects and the overflow frequencies. System configurations were identified and used as a basis for a cost effectiveness comparison of the alternatives. SFMAC results were also used to achieve the objective of establishing reasonable overflow frequency limits.

Local Data Availability

The required input data were available from conventional sources. An abundance of local data was available from the City of San Francisco, ABAG reports, and national census data to develop land use, runoff coefficient, and area data for all watersheds. This application was especially fortunate in having rainfall records spanning 69 years, which gave especially high reliability to the results of the modeling. The model can be effectively applied, however, with a shorter rainfall history and less extensive input data availability.

RESULTS

Reliability

As mentioned, the reliability of the San Francisco application of SFMAC was high. The repeatability of the results was excellent over 4-year and 69-year runs. However, the reliability of the results extends down to the monthly level of output only, as daily and hourly results are only representative. The program modeled system processes adequately.

Complexity

The application of a model to San Francisco has the potential of becoming unreasonably complex due to the size and intricacy of the system. The SFMAC model, however, adequately handled the task. Results were understandable and the volume of output was under user control. The overflow event data and mass balance summaries provided sufficient detail without generating a volume of data that would be impossible to review or comprehend. The model was a tool to gain comprehension of a complex system without obscuring the goals. The results were applicable to determine further implications of storage and treatment balances. The postprocessors also provided informative and understandable results.

The SFMAC model algorithm is simple and straightforward. An extensive educational program is not needed to help the user comprehend the model and its required input. In contrast, much effort from the user is required to implement some other detailed, single event models.

Accuracy

For the purposes of planning and comparison of alternatives, SFMAC is sufficiently accurate. Verification indicated the real situation is adequately modeled. As with all models, the accuracy of the results depends strongly on the input data. Quality parameters in the model are assumed to be conservative since complete mixing is assumed in storage and no sediment deposition is accounted for (the feature of modeling sediment deposition during the time when an overflow is occuring was added to the EPA version of SFMAC).

OVERALL EFFECTIVENESS

The overall effectiveness of the model in this application was high. The client and consultant were both able to significantly contribute to the model application process. The flow and quality concerns in a combined sewer system were adequately addressed. The planning objectives were met and preliminary sizing of a large number of diversified alternatives was accomplished.

ACCEPTANCE BY POLICY AND DECISION MAKERS

After first scrutiny and verification of the model for its applicability to San Francisco, city policy and decision makers freely accepted the model results. The model results formed much of the basis for the identification of and the subsequent narrowing of alternatives until the apparent best alternative was chosen.

The most significant use of the results was not just in city analysis of alternatives in the facilities plan. Information developed was also used by the regional water quality enforcement agency in an evaluation of appropriate overflow frequency levels to be included in NPDES regulations. Pollutant loadings developed from SFMAC runs and violation day data from VDAY were used in cost benefit analyses to determine overflow levels consistent with beneficial uses of the shoreline, ocean, and bay waters. In conclusion, the model results were accepted at several levels of the decision making process and were used to establish policy.

SECTION 9

MANAGEMENT AND MODELING ACTIVITIES

Management of a computer model application requires awareness of required expertise and a grasp of realistic budgets and schedules. These aspects of the SFMAC application are discussed. In addition, the integration of the model application with other ongoing planning efforts is also addressed in this section.

SPECIALIZED EXPERTISE NEEDED

Various levels of expertise were needed when working with SFMAC. Initial setup, regular use, and expanded application of the model all have different knowledge requirements. These three areas are discussed.

Initial Setup

When SFMAC was installed at a computer facility, familiarity with the computer facility was essential. The goal of initial setup was to create an object file on the system which could be accessed for regular batch runs. Familiarity with file handling statements and with the version of FORTRAN installed were especially important.

SFMAC was written using fundamental FORTRAN statements, making it compatible with most FORTRAN compilers. A person familiar with the computer system would most likely be able to find any quirks of the compiler which may not allow specific code statements. Code modification would then adapt SFMAC to that system.

For use on other facilities (non IBM computer installations), the code must be examined for file accessing statements. The code, as written, assumed unit definition prior to entering the program, with REWINDs (pointer update) inserted as needed within the code (typical of IBM installation). A common alternative means of accessing and defining files would be with the use of OPEN and CLOSE statements. The user setting up SFMAC would need to adapt the code to the system syntax. To do this, the user must be familiar with all file definition, input, and output operations.

Regular Use

After SFMAC had been installed on a computer system, normal use required much less computer oriented knowledge. The regular user of SFMAC needed to be familiar with the basics of operating on a system and with SFMAC input and output requirements. Required computer system knowledge involved use of the system text editor; data storage, access, and retrival; accessing the program; and file handling. The text editor was used to create input files, store data and output files, access the object deck to execute the program, and for file handling to be able to analyze output files and use them as lateral inflow files. The file handling expertise for regular use was much less than that required to first establish the program on the system. The user also had to be familiar with SFMAC to be sure it was being applied properly.

Future Application

In the event an application would be better served by some modification of SFMAC, say adding the capability of more pollutants, a much higher level of expertise would be required. Although the model algorithm was simple, a programmer with knowledge of the FORTRAN language and computer system abilities would be required to successfully make such changes.

BUDGET SCHEDULES

Typical Run Costs

The SFMAC production runs were executed on an IBM 370/168 computer. Representative run times and costs for 4 and 69 year tests are presented in Table 19. The cost benefit of making preliminary runs with representative short duration files is obvious.

Other major run costs involved printout. The relationship between the printout option and the number of pages of output is shown in Table 20. SFMAC had short summary output options or the user could specify full detailed printout. The user needed to exercise some caution in the selection of hourly printout, as in a run using 69 years of record, 306,607 pages of output would be generated.

Other sources of cost in such an application were disk or tape storage and terminal connect time fees. These items have not been included as they were highly system dependent.

Illustrative costs relating to use of postprocessor programs are presented in Table 21.

Table 19. TYPICAL SFMAC RUN COSTS
1980 Dollars

		4 month runs (all types)[a]		4 year runs[b]					70 year runs[b]				
	Object deck compliation	Hourly printout	Daily printout	Base	Combining	Final combining	Split	Ocean[c]	Base	Combining	Final combining	Split	Ocean[c]
CPU[d]													
Time, min	0.08	0.10	0.02	0.15	0.18	0.18	0.16	0.16	2.48	3.05	3.46	3.05	2.86
Cost, $[e]	2.24	2.40	0.56	4.20	5.04	5.04	4.48	4.48	69.44	85.40	96.88	85.40	80.08
Disk I/O[f]													
No. operations	98	48	48	101	287	404	217	1,400	124	17,255	12,011	4,871	4,873
Cost, $[g]	0.08	0.04	0.04	0.08	0.23	0.32	0.17	1.12	0.10	5.80	9.60	3.90	3.90
Tape I/O													
No. operations	--	--	--	--	--	--	--	--	234	950	1,185	240	234
Cost, $[h]	--	--	--	--	--	--	--	--	0.26	1.05	1.30	0.26	0.26
Tape mount cost, $[i]	--	--	--	--	--	--	--	--	1.40	2.80	2.80	2.80	2.80
Miscellaneous cost, $	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.20	0.30	0.30	0.30	0.30
Total cost, $	2.42	2.54	0.70	4.38	5.37	5.46	4.75	5.70	71.40	95.35	110.89	92.66	87.34

a. EPAMAC runs on IBM 3033 (faster execution times).

b. SFMAC runs on IBM 370/168 - monthly printout typical.

c. Recombining run.

d. CPU = central processing unit.

e. Cost based on rate of $28.00 per CPU minute.

f. I/O = input/output.

g. Charged at rate of $0.80 per 1,000 I/O operations.

h. Charged at rate of $1.10 per 1,000 I/O operations.

i. Charged at rate of $1.40 per mount.

Table 20. PRINTING OPTION AND PAGE VOLUME

	Subarea	Yearly	Monthly	Daily	Hourly
Introductory section	5 pages/ subarea	5 pages/ subarea	5 pages/ subarea	5 pages/ subarea	5 pages/ subarea
Core pages	1 page/ 10 subareas	1 page/ 15 years-subarea	1 page/ year-subarea	1 page/ mo-yr-subarea	1 page/ day-mo-yr-subarea
Final pages	2 pages/ subarea	2 pages/ subarea	2 pages/ subarea	2 pages/ subarea	2 pages/ subarea
Example No. of pages	16	18	54	494	14,614 (3,956)[a]
Example cost at $2.40/100 pages	$0.38	$0.43	$1.30	$11.86	$350.74 ($94.94)[a]

a. Wet-weather run only. If dry-weather flow is excluded, only each day with activity is printed. Example assumes 100 days of activity per year.

Example: 2 subareas, 20 years of data, daily printout

$$\overbrace{2\text{ subareas} \times \frac{5\text{ pages}}{\text{subarea}}}^{\text{Introductory}} + \overbrace{\frac{1\text{ page}}{\text{month}} \times \frac{12\text{ months}}{\text{year}} \times \frac{20\text{ years}}{\text{subarea}} \times 2\text{ subareas}}^{\text{Core}} + \overbrace{\frac{2\text{ pages}}{\text{subarea}} \times 2\text{ subareas}}^{\text{Final}}$$

$$= 10 + 450 + 4 = 494\text{ pages}$$

Table 21. TYPICAL POSTPROCESSOR RUN COSTS
(San Francisco Application)

	HISTO		VDAY	
	Compile[a]	Execute[b]	Compile[a]	Execute[b]
CPU[c]				
Time, min	0.02	0.42	0.08	0.48
Cost, $	0.56	7.56	2.24	13.44
Disk I/O				
No. of operations	52	28	170	84
Cost, $	0.04	0.02	0.12	0.06
Tape I/O				
No. of operations	0	25	0	481
Cost, $	0.00	0.03	0.00	0.43
Tape mount cost, $	0.00	1.40	0.00	1.20
Print				
Pages	35	163	73	127
Cost, $	0.84	3.91	1.75	3.04
Miscellaneous cost, $	0.40	0.37	0.95	3.02
Total cost, $	1.84	13.29	5.06	21.19

a. Run on IBM 3033.

b. Run on IBM 370/168; overflow flow only for 4 years.

c. CPU = central processing unit.

Scheduling

The time requirements for application of the SFMAC model to San Francisco are presented in this section as an aid to the reader. The total time required for the analysis has been divided into application categories and listed in Table 22. A simpler wastewater system would probably have proportionately less time involved with the production run and final analysis phases.

Table 22. DISTRIBUTION OF TIME REQUIREMENTS FOR SFMAC APPLICATION
Percent

	In general	For San Francisco
Data gathering and analysis	30-50	30
Analysis selection, setup, and calibration	20-25	20
Production runs	10-15	15
Final analysis	10-30	30
Miscellaneous	5	5

The number of production runs totaled about 50 for the San Francisco alternatives: 23 base runs, 10 initial combining runs, 9 area and fine tuning runs, 3 split runs, and 1 final ocean plant run. When multiple alternatives were being analyzed, subsequent executions did not repeat the 23 base runs. Where different lengths of record were being tested, the full 50 runs applied to the short record test runs only. The long record files were not subject to the fine tuning run costs for a total of about 40 runs per alternative. Depending on the alternative being analyzed, not all alternatives were carried past the fine tuning runs. Split runs and postprocessor runs were used predominantly in the latter stages of the planning process. About three postprocessor runs were needed for alternatives selected for that detail of examination.

INTEGRATION WITH OTHER PLANNING ACTIVITIES

Throughout the SFMAC application, results of other ongoing planning activities were incorporated in the planning process. Results were incorporated in the selection of alternatives and aided in the development of VDAY. Coliform die-off studies determined no disinfection was required for wastewater to be discharged into the ocean outfall, and bayside die-off coefficients were incorporated into VDAY. Results from outfall dispersion modeling were also used in determining allowable effluent concentrations and loadings that influenced the modeling. As previously mentioned, SFMAC modeling also had effects on ongoing planning. The model is continuing to be used in subsequent planning efforts.

PART III

EPAMAC MODEL DOCUMENTATION AND USERS' GUIDE

SECTION 10

GENERAL DESCRIPTION

The third part of this report deals with the program user instructions, basis in theory, and documentation detail. The MAC model and postprocessors, as described herein, are SFMAC as revised and adapted for general use, and renamed EPAMAC.

EPAMAC PROGRAM

The transition from SFMAC to EPAMAC involved several small changes in values, printing format, and input format. The one major addition unique to EPAMAC is the ability to model pollutant removals due to sedimentation in storage. SFMAC did not require this feature, since calculated velocities in the system are expected to scour any sediment that might settle. The changes incorporated in EPAMAC are discussed.

Added Capabilities and Features

The major addition to EPAMAC is the feature of modeling pollutant removals due to storage sedimentation. The phenomena are modeled by a simple user specified percent removal of either SS or BOD. The proper application of this feature is presented in Appendix C.

Another added feature is the ability to define the water year starting month. In the San Francisco Bay Area, it rarely rains from June through September, so a June starting month was appropriate. The user can now specify a month most suited to the local climate or calendar year. Also, up to 998 years of rainfall can now be input.

Other features include one statement to change unit assignment for FORTRAN READ and WRITE statements, more orderly output format, and an additional printing frequency option. All numerical values specific to the San Francisco application were converted to user specified values.

Additional Restrictions and Limitations

Inherent with additional features are additional restrictions and limitations. Because EPAMAC is a broad scale model, incorporating storage pollutant removal requires higher user comprehension of the model to be certain the feature is being used appropriately. Appendix C has been included as a guide to the user. The percent removal method will give a rough estimate to see if such removals are significant for the system being studied.

Also, the user must be certain that the first rainfall data month and year does not precede the beginning date of the rainfall input file or an infinite loop will occur. A minimum of 20 years of record is required by the postprocessor VDAY.

POSTPROCESSOR PROGRAMS

The HISTO program, which prints summary tables and graphs from EPAMAC, did not require major changes when adapting it to general use. Minor changes in the printing formats were all that were required.

The VDAY program required numerous changes, most of which were minor, to convert it for general use. The added capabilities and features include: (1) a statistical analysis of the overflow events and violation days based on a ranking of the actual values, (2) the option of the user to select specific periods from the overflow file for analysis, and (3) revision and improvement of the output table headings.

Specific limitations of the VDAY program include the following: (1) the maximum length of the simulation time period is 70 years, (2) the range of usable years for the simulation is from 1900 to 1998, and (3) the five violation day criteria within the program are not variable without changing the program code statements.

SECTION 11

USER INSTRUCTION

This section is a guide to the user in applying EPAMAC and the postprocessor programs HISTO and VDAY. Preliminary processing of information, input data preparation, output description, and interpretation of results are discussed. The individual who will initially establish the model on a computer system should be familiar with the information presented here. However, specific recommendations on establishing the model on a system are presented in the following program documentation section.

EPAMAC

The following discussion leads the user through the EPAMAC application procedure. Sufficient explanation is provided at each stage to permit selection of input variables. Detailed presentation of technical concepts or program documentation are contained in subsequent sections.

Program Processing Steps

The application of EPAMAC is a multiple step process. The major steps are: (1) development of a system schematic, (2) selection of alternatives to be analyzed, (3) preparation of input data files, (4) execution of the computer run, and (5) interpretation of the results.

Typically, the first requirement is to develop schematics of existing and alternative future systems of handling wastewater. Establishing the schematics and using the schematics to identify the needed EPAMAC computer runs are described in this section. Computer runs can be classified into base, combining, and final runs. Base runs generate runoff volumes from the individual watersheds. Combining runs integrate the runoff, dry-weather flows, and physical system characteristics (such as storage and treatment capacity) from several subareas to determine the major watershed wastewater characteristics. Final runs isolate particular flow streams for analysis, combine major watershed wastewater flows (usually in large systems), and involve analysis by postprocessor programs. Uses of the system schematics relating to the three levels of computer runs are described.

System Schematics

The first step in applying EPAMAC is the development of a wastewater system schematic. This schematic will be a tool throughout the entire application procedure. The goal is to express the wastewater system in EPAMAC terms. The wastewater system is to be described as various combinations of individual watersheds, lateral inflows, conveyance routes, storage, and treatment units, as shown in Figure 20.

To develop a system schematic, the user should define the study area using a base map depicting existing wastewater facilities as shown in Figure 21. The study area consists of all watersheds draining into the wastewater system. Each watershed in the study area should be identified and the direction of drainage marked as determined by topography and existing drainage system maps. The small watersheds in the study area are called subareas. An EPAMAC run on each subarea constitutes the base runs. Major watersheds can also be identified at this time by grouping all subareas that have the same discharge location. In the San Francisco example (presented in Part II of this report), three major watersheds exist. The example presented in this section is one of those major watersheds with eight subareas, as shown in Figure 22.

Further examination of the flow routing in the system will illuminate logical ways of grouping the subareas for the combining stage of EPAMAC application. In the example, a rough sketch of the flow paths leads to the schematic of the system, as shown in Figure 23. Other existing characteristics added to the schematic include storage capacity (if any) and treatment or pumping rate (if any).

The model limits the maximum number of inflows to four, so intermediate combining runs are required for systems with more than four subareas. Referring to the schematic in Figure 23, notice that subareas 1, 2, and 4 join together and are conveyed to the treatment plant via a common pipe. A logical combining point would then be before entering the conveyance pipe. Subareas 3, 5, 6, and 7 all merge on the treatment plant in a similar fashion and could also be combined. Thus, two combining runs would be made: one combining subareas 1, 2, and 4 at point A and the other combining subareas 3, 5, 6, and 7 at point B. Area 8 is isolated and would be left separate. The user is now only dealing with three lateral inflow files A, B, and 8.

In the example, shown in Figure 23, the combining runs are simple since no storage or treatment exists in the upstream portion of these subareas. If storage did exist, it would be incorporated in the first level of combining runs (creation of files A and B). The last combining run for the example, will have files A, B, and 8 as lateral inflows. In this example, files A and 8 are delayed

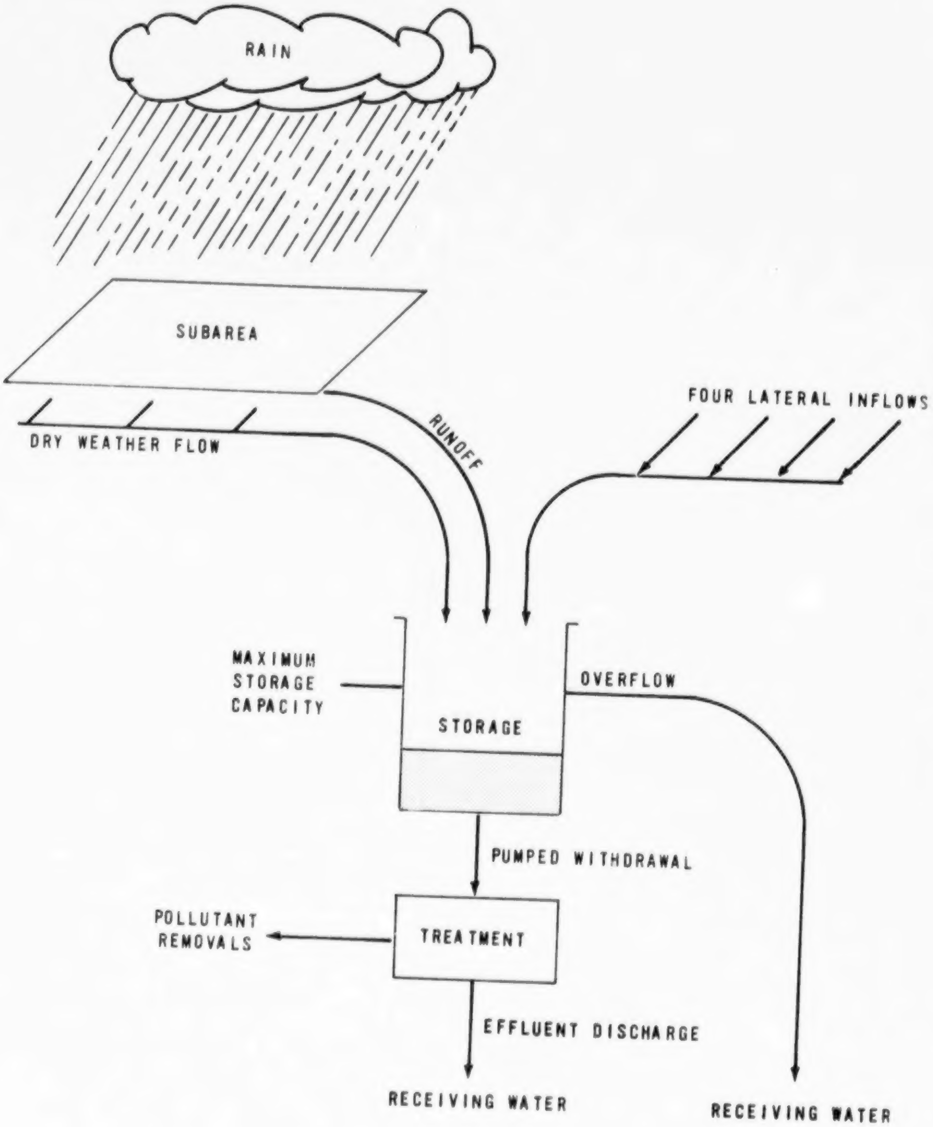


Figure 20. EPAMAC schematic.

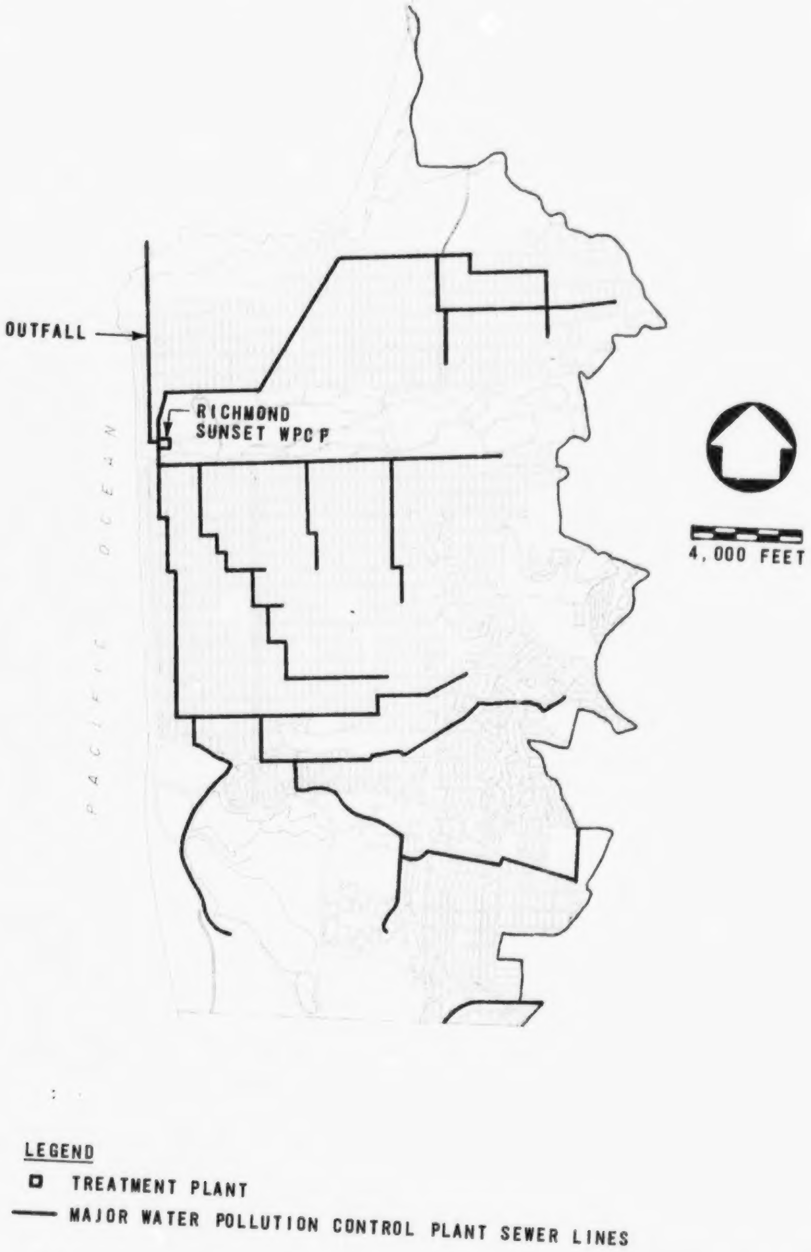


Figure 21. Existing facilities for Richmond Sunset WPCP, San Francisco.

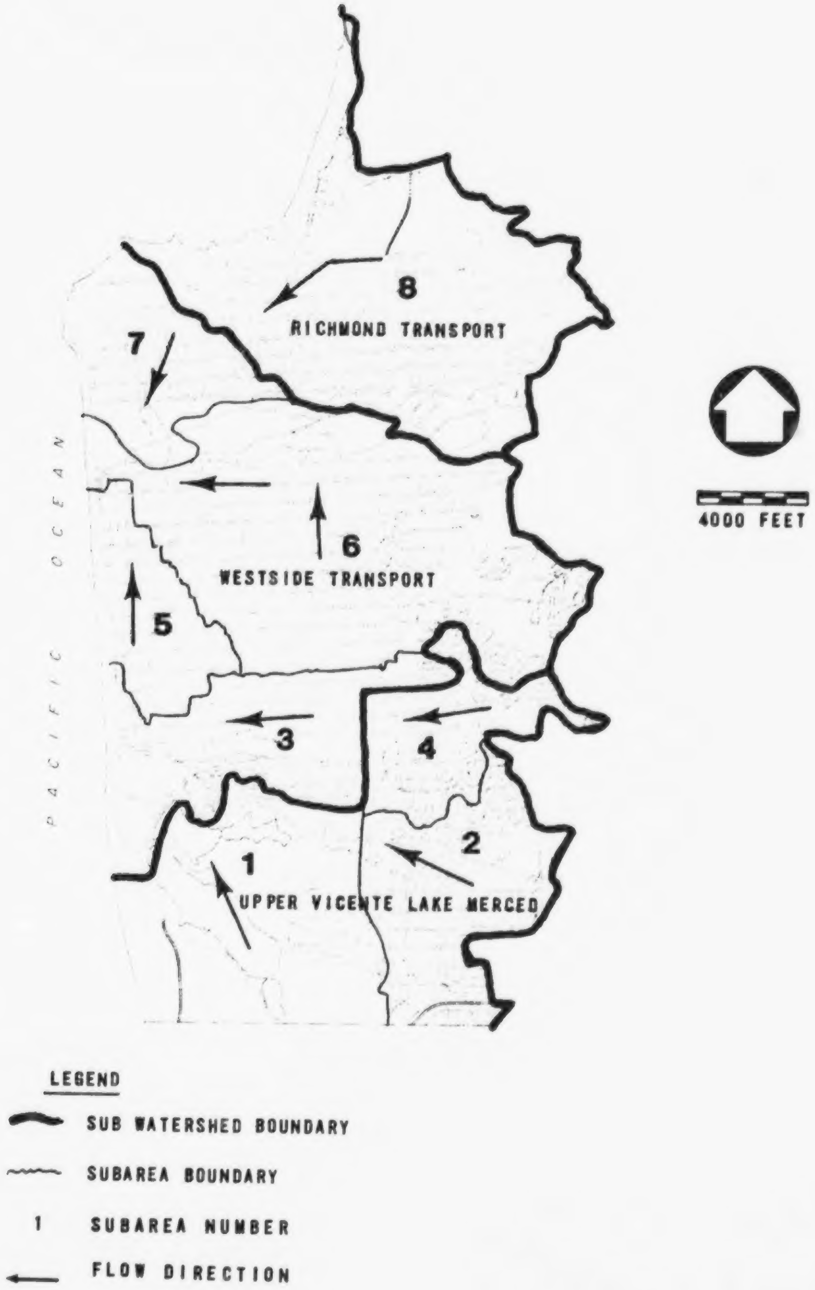


Figure 22. Watershed and subarea identification.

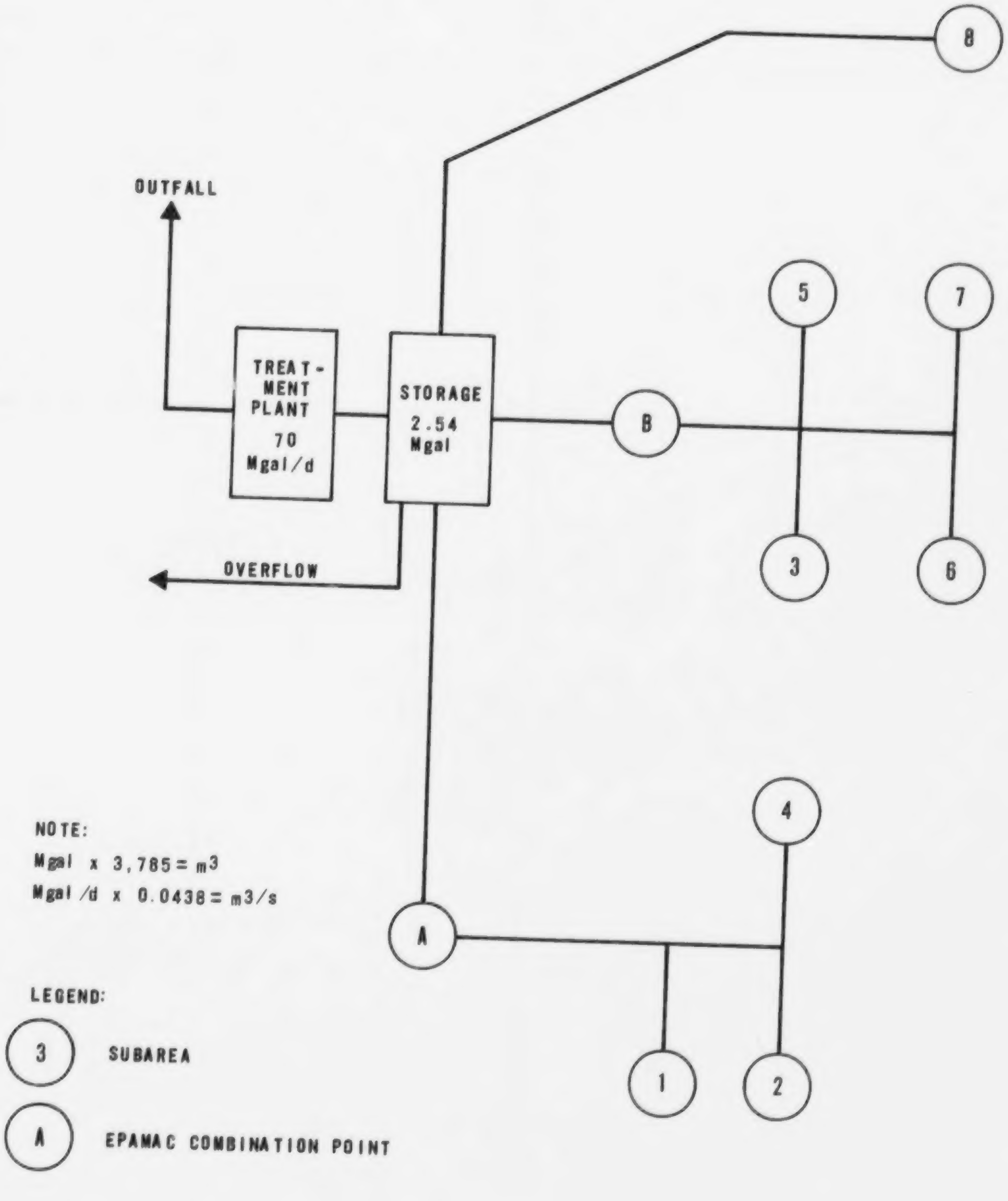


Figure 23. Existing conditions: flow schematic diagram.

1 hour each to account for travel time (2.5 miles at 4 ft/s = 1 h). Travel time delays must be in 1 hour increments due to the time steps used in the program. The maximum treatment/pumping rate is 70 Mgal/d (3.1 m^3/s) and storage is 2.54 Mgal (9,600 m^3). Since this is a combined sewer system, dry-weather contributions are also included on this run. Had dry-weather flow records existed for each of the subareas, the dry-weather contribution could have been incorporated in earlier combining runs. In this example, data existed only at the treatment plant, so the dry-weather flows were added in the final combination run.

Final computer runs can be executed to separate dry- and wet-weather flow streams for further identification. The postprocessor programs can also be applied at this point in the EPAMAC analysis. Refer to VDAY and HISTO portions of this section for explanation of their postprocessor application procedures.

Alternative Analysis

After establishing an existing condition schematic, as in Figure 23, and noting how computer runs will be used to model the existing system, alternative analysis can begin. Depending on the goals, flow can be rerouted, treatment upgraded or expanded, or storage added in various alternatives. Schematics must be developed for the alternatives. The schematics for the alternatives will again outline the required EPAMAC runs. The base, combining, and final runs are applied to alternative schematics as described for the existing system schematic.

A schematic for a possible alternative is shown in Figure 24. The same A and B files from the existing condition run can be input to a new combining run for the alternative with larger storage capacity and less treatment capacity. Wastewater from subarea 8 would be processed as a separate final combining run. In the case of a combined sewer system, the dry-weather fraction attributable to subarea 8 would be separated out based on population or other logical method.

At this point, the user should understand how to establish existing system configuration and alternative systems to be analyzed. Schematics of all systems to be analyzed or compared should be developed as an outline for executing the computer runs.

Execution Logistics

If EPAMAC is applied to a large wastewater system, the logistics of file handling can become confusing. The user should establish a naming convention at the beginning of an application and adhere to it. To aid the user in establishing a file handling

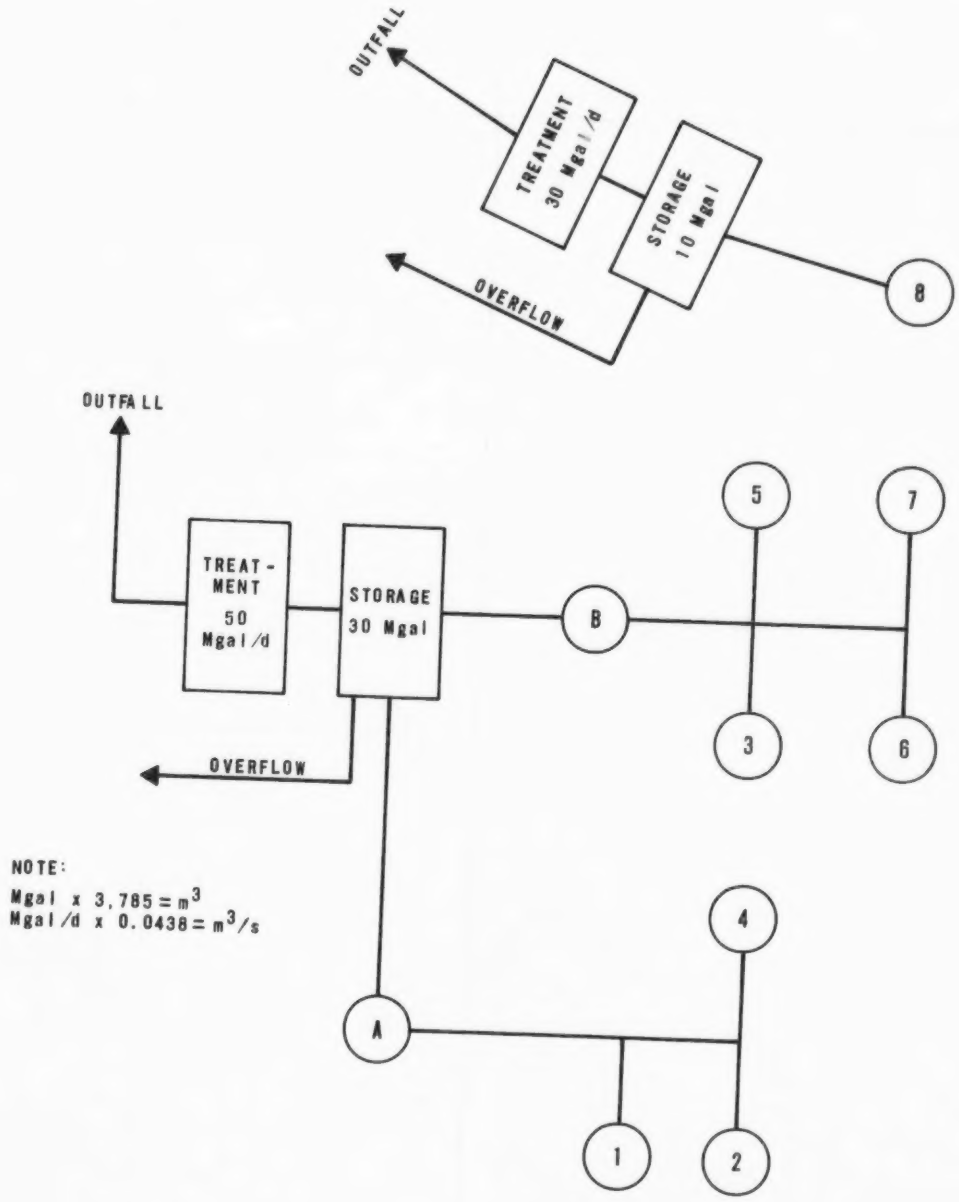


Figure 24. Alternate condition: flow schematic diagram.

procedure, the types of files generated and their handling are discussed.

Base runs typically have one data input file, no lateral input files, and generate one output file. If zero storage volume and zero treatment rate are specified, the output file will be an overflow file. If infinite storage volume and pumping rate are input with no treatment, the identical file will be produced, but will be a treated file. The terms overflow and treated are references to the creation path taken in the program. In all other ways, these files are identical. Many different alternatives can use the same base runs. Hence base runs should be identified in a naming convention with the subarea and not a particular alternative.

Combining runs will have an input data file and one to four lateral inflow files. If it is an intermediate combining run, typically one output file will be generated. In a final combining run, two output files are created: one treated and one overflow.

In a combining run for combined sewer systems, the treated file may consist of both dry- and wet-weather flow components. Should treatment facilities for wet-weather flow be at a different treatment level than dry-weather facilities, three runs are made. The first run is a combining run without treatment levels specified. System storage and total dry- and wet-weather pumping capacities separate the overflow volume (overflow file) from the dry- and wet-weather flow volumes. The dry- and wet-weather volumes comprise the treated file. This treated output file is input to a second separation run isolating the dry- and wet-weather portions (also called a split run). The second separation run would specify zero storage capacity, dry-weather pumping capacity, and dry-weather treatment removals, resulting in the wet-weather flow appearing as the overflow file and the dry-weather flow as the treated file. This overflow file could then be processed in a third run specifying wet-weather treatment removals and pumping rates resulting in the wet-weather flow appearing in the treated file. No overflow file is generated in the third run.

Combining runs tend to vary according to alternatives analyzed. Hence, part of the name of a combining run output file should identify which alternative is being analyzed. Labeling the creation path of a file as treated, TR, or overflow, OV, may also be helpful. A sample of naming conventions used for the example is presented in Table 23.

Table 23. EXAMPLE FILE NAMES

	Input files[a]	Output files
Base run	--	AREA01 AREA02 AREA08
Combining		
Intermediate	AREA01, AREA02, AREA04	UVOV
	AREA03, AREA05, AREA07, AREA06	WSTOV
Final	UVOV, WSTOV, AREA08	ALT2TR ALT2OV
Final		
Separation	ALT2TR	ALT2DWTR ALT2WWOV
Treatment	ALT2WWOV	ALT2WWTR

a. Input data deck and rain file not included. Assumed present for all runs.

Logistics of handling input and output files not only involve identification but also physical space for the files on the computer system. The two most common forms of storage are on disk or magnetic tape. Usually, files will be read from and written to disks. Computer systems with limited disk space, or where large rainfall records are to be processed, may require reading and writing files from tape. Long-term storage of files generally should be on magnetic tape.

In the San Francisco application, 4-year and 4-month files were accessed and saved on disk until no longer needed. Sixty-nine year runs, however, required reading from and writing to tape for each computer run due to the size of the output files. A comparison of typical file sizes is presented in Table 24. A detailed discussion of file handling control language (how to read from and write to files) is presented in Section 13.

Instructions for Input Data Preparation

At this point, the user should have developed the existing system schematic and alternative flow schematics to be tested. The user should also have an understanding of how files are manipulated on the computer system and their relation to each other.

The input file is tailored to each run, although certain portions can be duplicated for other runs. It is useful to have master input data files for base, combining, and final runs that can be modified for each individual run without retyping all the input lines. A blank example of the format of all input cards is shown in Figure 25 and a typical data deck setup for EPAMAC is shown in Figure 26.

Table 24. EPAMAC INPUT AND OUTPUT FILE SIZES[a]

	Disk[b]	Tape[c]
4 month	3-4 tracks[d]	1 ft
4 year	20-30 tracks	7 ft
69 years	590-600 tracks	104 ft

a. Does not include input of approximately 1 track; rain files, approximately 60 tracks/ rain file with a logical record length = 120.

b. IBM 3,330 disk.

c. 6,250 BPI density; 69 yr blocksize = 32,700; 4 yr blocksize = 6,233.

d. Variable blocksize.

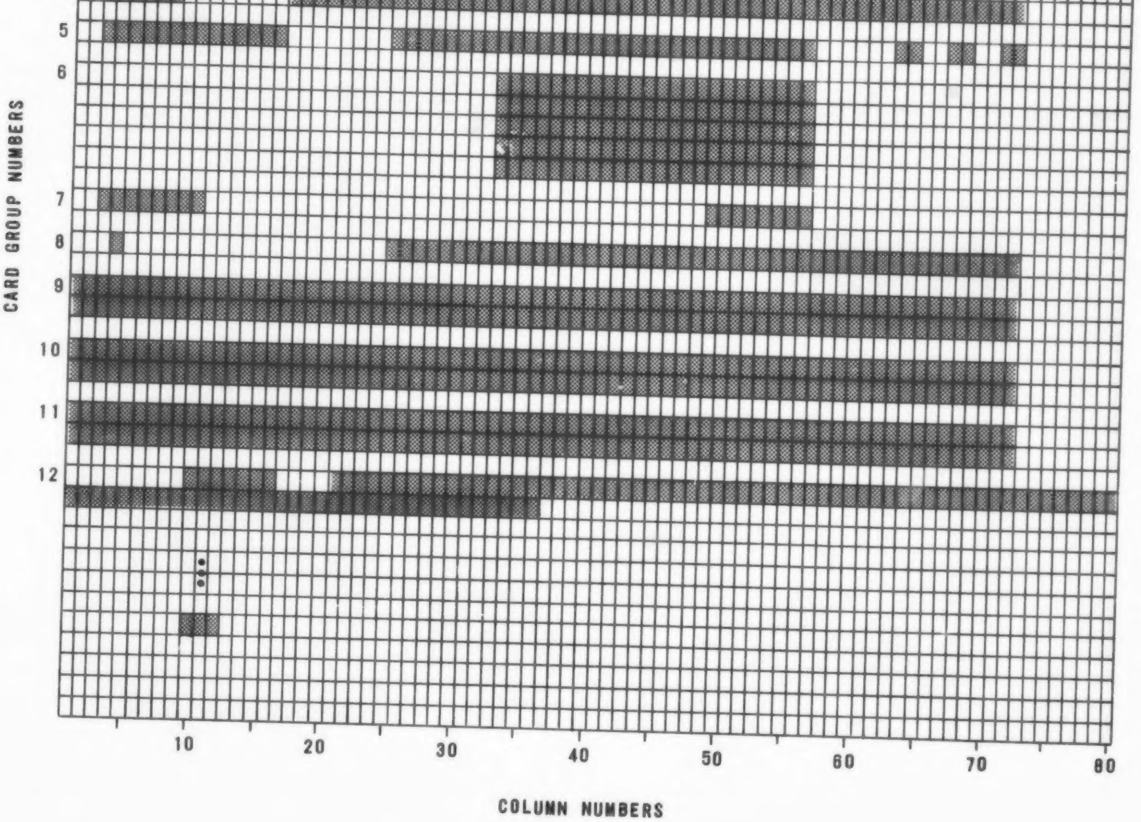
ft x 0.305 = m

Each category of input data will be examined for type of information needed, data sources, analysis of options possible, and discussion of basis for selection of the options. Variable names used in the program will be in capital letters. An example section will summarize the input data sequentially.

Rainfall--

It is recommended that a minimum of 10 years of rainfall record be used in any analysis. Shorter records may be used if statistical comparisons of the long- and short-term records can be correlated. The rainfall record must consist of the date (year-YDATA, month-MDATA, and day-DDATA) and rainfall-RAIN in units of hundredths of an inch. Several sources of rainfall data are available. Data from local recording rain gages are the most accurate source. Municipalities, utility districts, and flood control districts are three possible sources of local data. Information from these sources must be checked to determine if sufficient length of record and required data are available. State agencies may also have recording rain gage information.

Another source, the National Weather Service National Climatic Center in Asheville, North Carolina, maintains primary recording rain gages across the United States. Much of the data begins in



BLANK LINES HAVE BEEN INCLUDED BETWEEN INPUT DATA GROUPS FOR CLARITY OF FIGURE. ACTUAL INPUT DATA SHOULD NOT HAVE BLANK LINES

Figure 25. EPAMAC input data cards format.

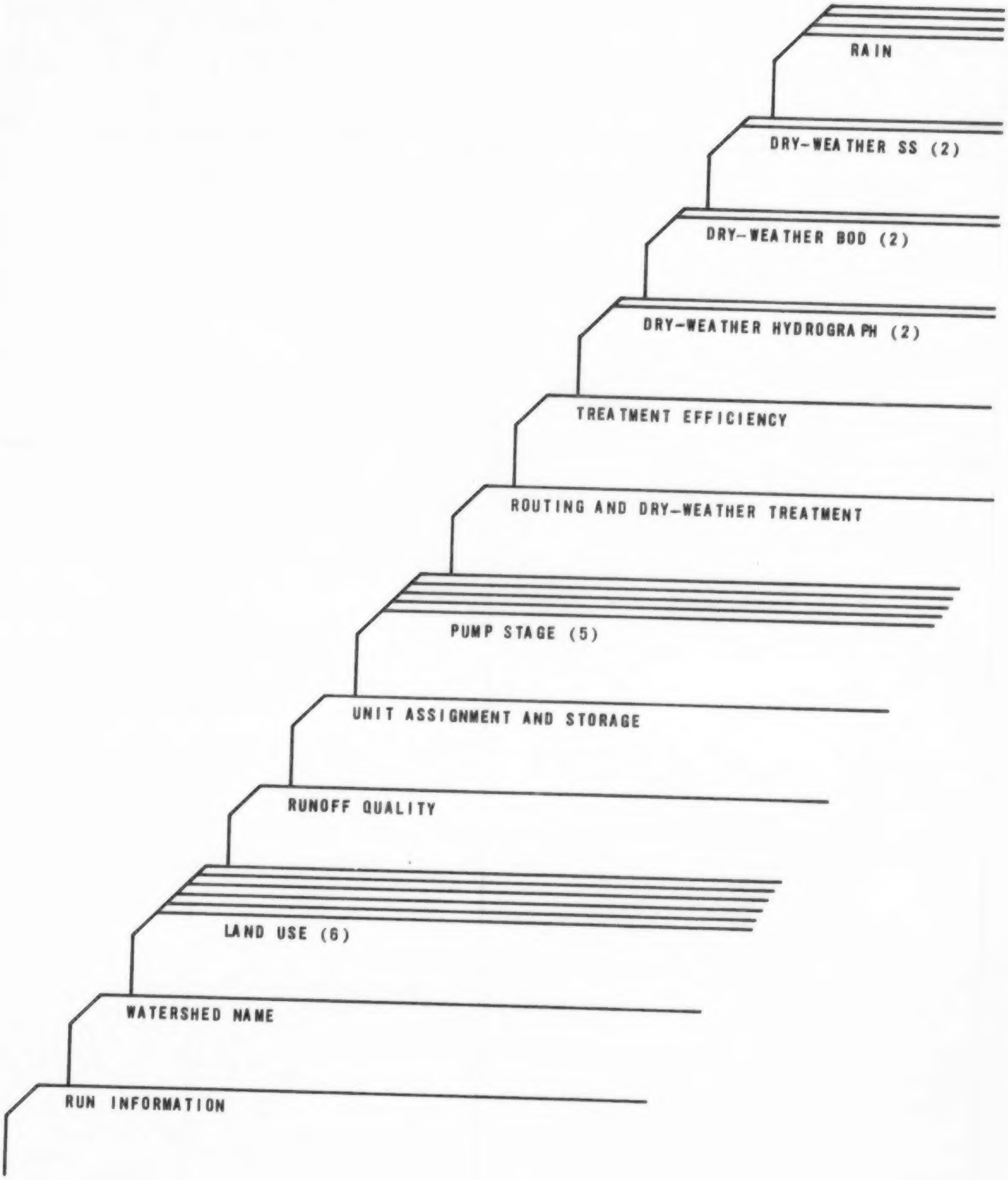


Figure 26. Data deck for EPAMAC.

1948 and is compatible with EPAMAC requirements. Magnetic tapes of data for specific gages can be purchased from the National Weather Service. Past experience indicates tapes can be obtained within a few weeks for a nominal charge ($100 to $200).

Once the rainfall data have been obtained, they must be converted to EPAMAC input format. Figure 27 illustrates the positioning of the rainfall data in relation to the EPAMAC input card groups. When the rainfall source data are obtained, the data format should be compared with the EPAMAC format. If necessary, the user should prepare a program to convert the data to an EPAMAC format rain input file.

Other input variables relating to rainfall are RFAC, MWTYR, and MRODRY. The locations of these variables are also shown in Figure 27. RFAC, the rainfall multiplier factor, is the ratio of average rainfall for the study area to the average rainfall at the rain gage location. If local data are used, this factor is 1.0. However, if the rainfall gage data are not local, RFAC must be determined using graphs of average annual rainfall contours (isohyet-maps).

MWTYR is the user specified starting month of the water year. If the calendar year is used as the water year, MWTYR would be 1 for January. For the San Francisco application, MWTYR was 7 for July (July through September are traditionally dry months). The location of MWTYR year in the input data is shown in Figure 27.

MRODRY is the third rainfall related variable. This variable specifies the minimum time period that must elapse without any rainfall to signify the end of a storm event. For the San Francisco application of EPAMAC, a 6-hour value of MRODRY was chosen. A shorter time period would have increased the number of events by allowing short breaks in a storm to be counted as two events. Examination of rainfall patterns for the locality will aid in selection of appropriate value of MRODRY. The input location for this variable is shown in Figure 27.

Statistical analysis of the rainfall data is recommended. This analysis aids in the selection of MWTYR and MRODRY, as well as in the selection of design storms and interpretation of results. Specific analysis on duration, frequency, and intensity of rainfall data can be especially useful. In addition, such analyses can help in the selection of a short time period representative of average conditions for the entire length of record. Test runs can be run using a small rainfall data file to determine appropriate input values for system alternatives. The selected values can then be run only once or twice using the full rainfall input file resulting in reduced computer charges.

The rainfall file is used in base runs to generate the runoff volumes. A rainfall file is also required for combining and

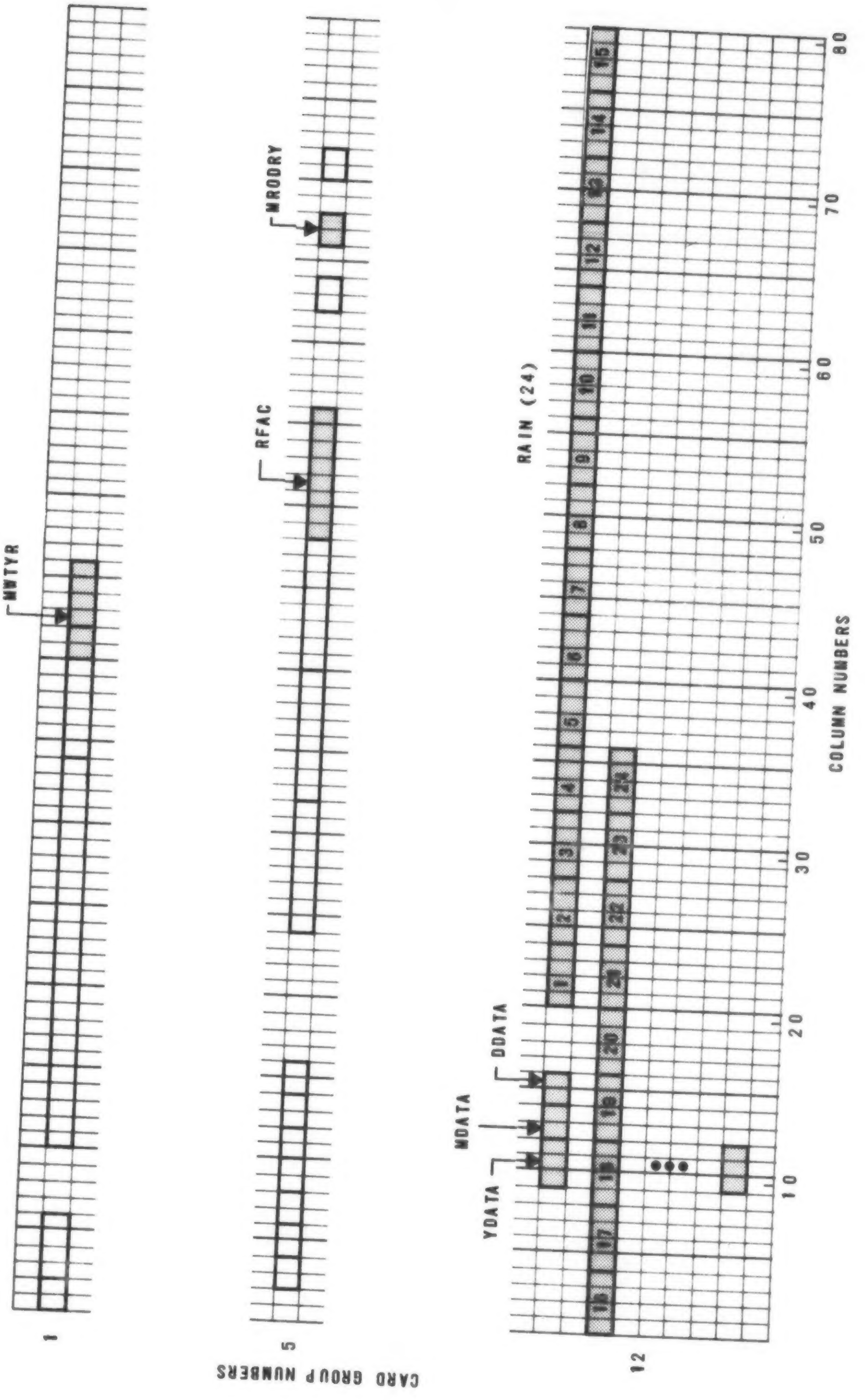


Figure 27. Rainfall variable format.

final runs. The file data are not used to generate runoff in the combining and final runs, rather the file functions as a clock to force subsequent runs to execute over the same time period.

Watershed Characteristics--

The next input category is watershed characteristics. Required watershed characteristic input data are area, land uses, and runoff coefficients.

EPAMAC requires the total watershed area, the types of land uses, and the area of each land use. The user can specify up to six land uses in each watershed.

Sources of land use data are city, county, or other local planning agencies. Often this information is gathered as part of the development of general plans. Land use data also can be developed by using aerial photos and USGS base maps. Most common land use categories are open space, low density residential, high density residential, commercial, industrial, and agricultural.

The land use name is entered as 20 alphanumeric characters into the array AUSE. Area becomes part of the array AREA. If the watershed(s) being analyzed only have two or three land use types, then the user can leave the unused input cards blank. The location of these variables is shown in Figure 28.

The land use areas are used to compute the watershed's weighted runoff coefficient. The weighted runoff coefficient is used to determine runoff. The EPAMAC model requires runoff coefficients to be specified for each land use. The runoff coefficient is a value from 0 to 1 representing total to no absorption of the rain into the ground, respectively.

Where average rainfall records and average runoff values (from stream recording gage) are available for an area, these average values can be used to calculate a representative coefficient value. Typical values for several land uses are listed in Table 25. The selected runoff coefficient values are input as array ROK as shown in Figure 28.

Three other variables should be determined at this time; WASHED, WNAME, and AKOVER, as shown in Figure 28. WASHED is a 20 character variable for the watershed name used in the computer printout headings. WNAME is a secondary or additional name variable that can be used to further identify the EPAMAC run. This 20 character variable is also used in headings. The third variable the user can specify, if appropriate, is AKOVER. AKOVER is a runoff coefficient override. If the watershed weighted coefficient is known, but the individual land use coefficients are not, the user can enter a value of AKOVER that supersedes any value calculated from use of ROK values. The ROK values are

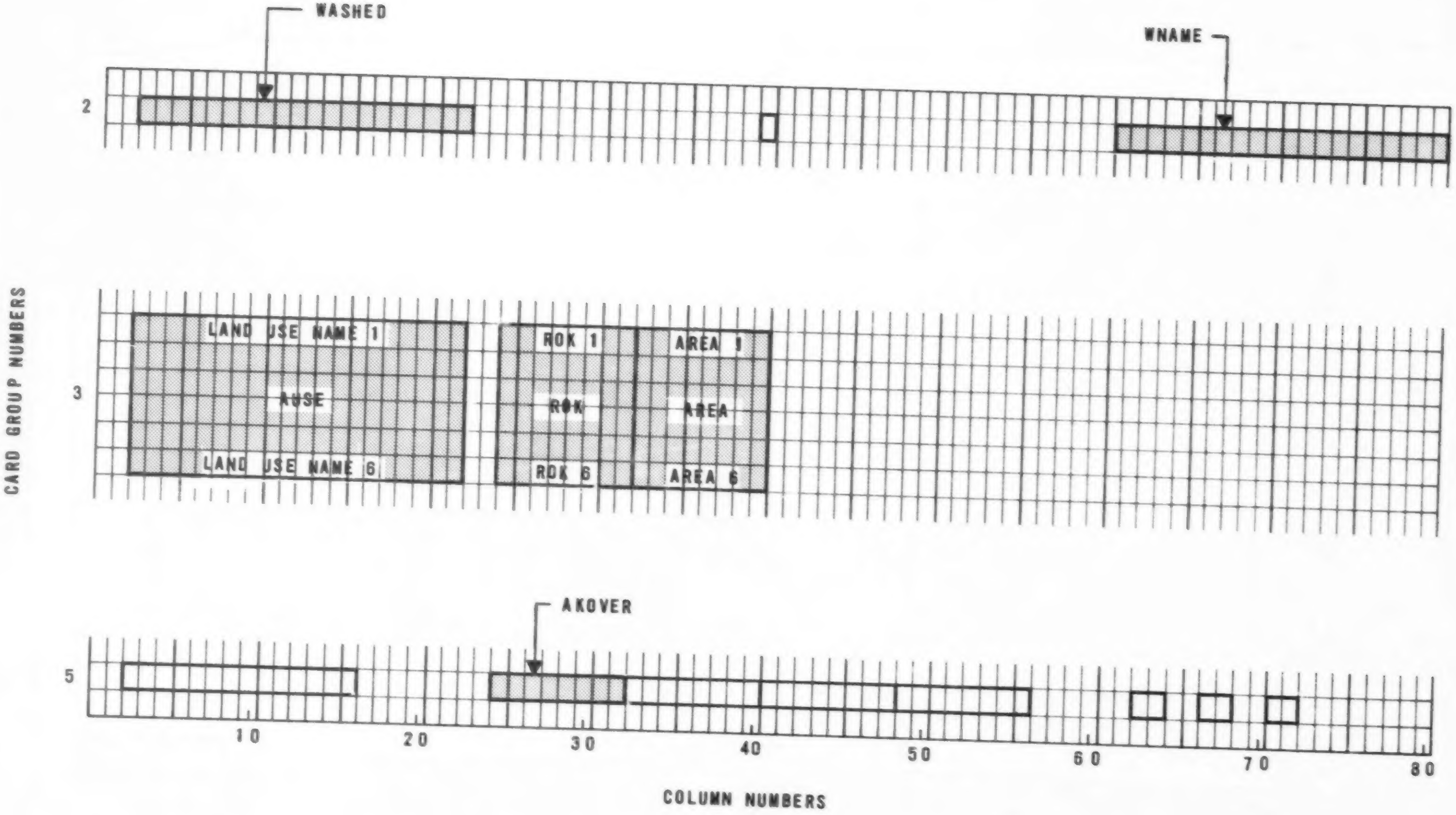


Figure 28. Watershed characteristic variable format.

overridden only if the value of AKOVER is greater than zero. The user, at a minimum, can specify AKOVER and areas, and not input individual ROK values. The user will probably find AKOVER most useful when land use configurations do not change and only physical facilities are being modified.

Table 25. TYPICAL RUNOFF COEFFICIENTS

Land use	K factor	Range
Residential	0.3	0.2-0.58
Multifamily residential	0.4	0.4-0.55
Commercial	0.7	0.3-0.9
Industrial	0.6	0.3-0.9
Open	0.2	0.1-0.3
Agricultural	0.1	0.15-0.25

If different combinations of land uses are being tested, say for future development, then use of the ROK array is more appropriate. The ultimate goal of selection of ROK or AKOVER, AUSE, etc., is to determine the runoff generated by rainfall in base runs. Combination and final runs will not have runoff coefficients specified. The other parameters in this category are optional for combination and final runs, and serve identification purposes only.

Water Quality Characteristics--

The next classifications of input parameters are water quality characteristics. Stormwater runoff characteristics of BOD and SS are input as concentrations in units of mg/L. Dry-weather flow and BOD and SS loads are input as diurnal patterns with 24 values specified for each hour in a day. Flow is in units of Mgal/h and the dry-weather pollutant loads are expressed in units of klb/h.

Sources for wet-weather BOD and SS concentrations can be grab samples, or previously reported data. Actual sampling of watershed runoff is recommended to obtain site specific data. Three concentration values for each pollutant must be specified. The three values represent concentrations in the first, the second, and all subsequent hours of the storm event. If only one data point is available, enter it for all three values. However, if first flush relationships are known, the first two parameters can represent the early peaks and the third parameter can represent average concentration for the remainder of the rainfall event.

A primary source of data for dry-weather flow characteristics is treatment plant records. Average dry-weather flow and pollutant loads are developed from these records. Also, average diurnal flow and load variations can be determined and applied as factors to develop EPAMAC input.

If treatment plant records are not available, and dry-weather flow exists in the watershed, the user must develop the required data. If the flow is typical sanitary flow, estimates can be developed using existing population figures and multiplying by per capita water use. A complete description of the procedure and typical domestic wastewater concentrations are presented in most sanitary engineering texts. A sampling program will be needed to establish diurnal patterning if no data exist. If no reasonable basis for diurnal pattern can be established, enter equal values over the 24-hour period.

The wet-weather concentrations are entered as arrays BCONC and SCONC. BCONC contains the BOD concentrations, and SCONC contains the SS concentrations. The location of these variables is shown in Figure 29. Dry-weather flow is array DWF; DWFB contains the BOD loads for dry-weather flow, and DWFS contains the SS dry-weather loads. The positioning of these arrays is also shown in Figure 29.

One other variable related to water quality should be specified at this time. The variable RAINMN (see Figure 29) represents a minimum rainfall condition that must be reached before EPAMAC will reset to allow first flush concentrations to be used. EPAMAC uses RAINMN and MRODRY to determine when pollutant accumulation is sufficient to warrant using the first flush concentrations.

The user typically specifies wet-weather concentrations in subarea base runs. Dry-weather characteristics need not be incorporated until the combining runs.

System Physical Characteristics--

The next classification of input variables is the physical characteristic of the system being analyzed. The physical characteristics EPAMAC requires are: maximum and critical storage volume, pumping rates, pump on/off water levels, and the selected pumping operation mode.

Sources for this input data are not the same as previous input categories. Some material may be available for existing conditions from engineering or public works department drawings and calculations. However, for future conditions and various alternatives to be studied, the user must draw upon personal judgment and goals of the analysis. Plans for future design or expansion may provide some assistance in establishing a starting point for alternative analysis.

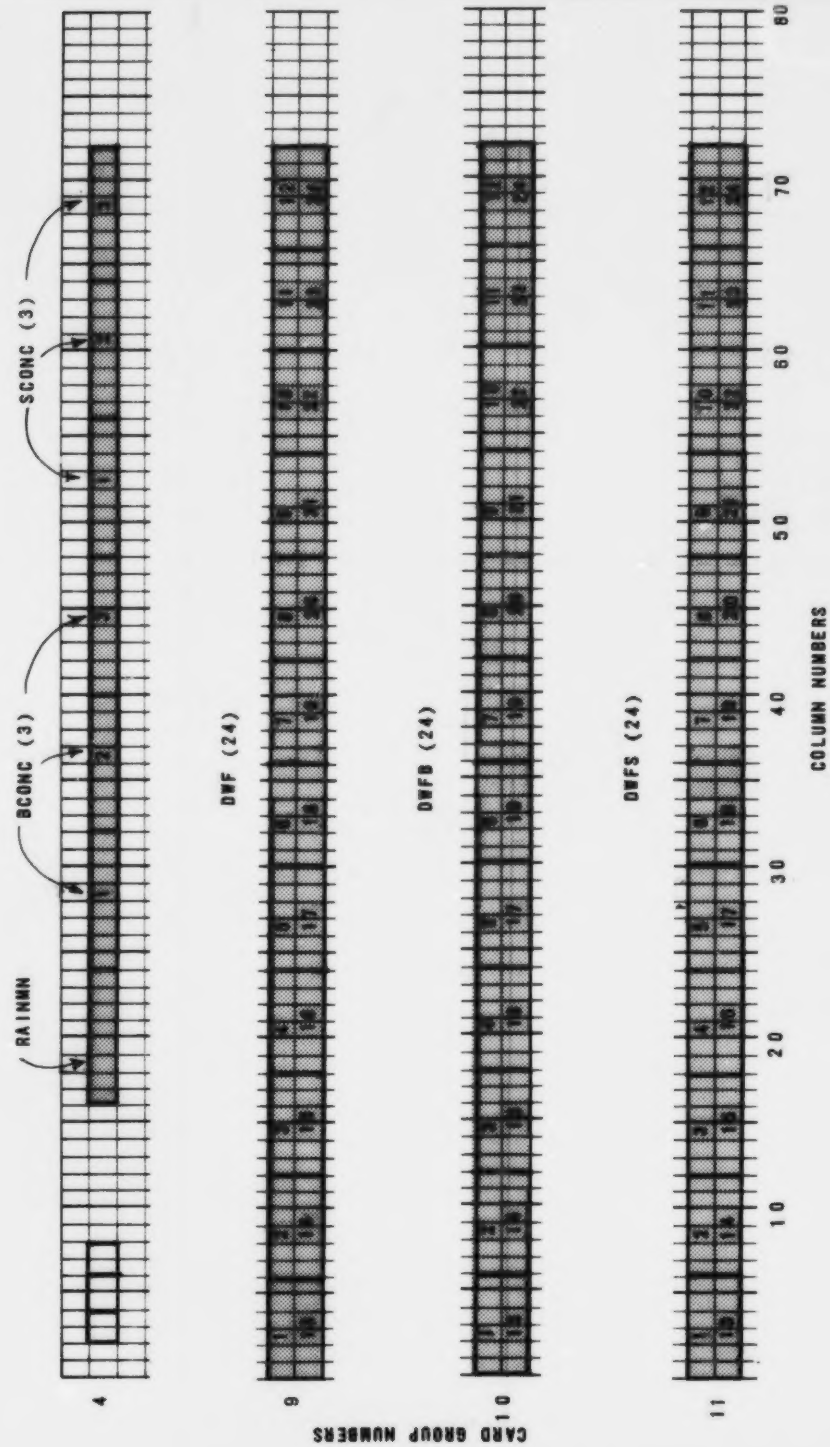


Figure 29. Water quality characteristic variable format.

The maximum and critical storage volumes to be selected are variables STMAX and STCRIT. STMAX is the maximum system storage volume available. STMAX should be a summation of volume in storage tanks, excess volume in conduits or transport lines, or any other storage volume upstream of the treatment facilities. STCRIT, the critical storage volume, is used in pump control. STCRIT must be reached before withdrawal pumps can be triggered. The effect of STCRIT is to delay pumping and pumped flow. The location of all variables discussed relating to system physical characteristics is shown in Figure 30.

If storage is to be modeled, a pumping or treatment facility must be present to empty storage. The intent is to provide for some type of orderly withdrawal from the total storage volume rather than from a specific storage unit. Several configurations of how reality can be approximated by model parameters are demonstrated in Figure 31. Storage without overflow is not specifically modeled by EPAMAC. Storage facilities best modeled by EPAMAC are those that overflow to receiving waters or bypass treatment units. The overflow files can also be used as lateral inflow files depending on the system being modeled.

Pumping flowrates are input to array WPUMP. The five values of WPUMP that can be specified function as different levels of wet-weather pumping. Each value of WPUMP should be a summation of all wet-weather pumping capacity available at that stage. An additional variable DWTRT is the maximum dry-weather pumping capacity. WPUMP and DWTRT together constitute the full range of storage withdrawal capacities used in EPAMAC. Table 26 illustrates the pump stage capabilities.

Table 26. EPAMAC PUMP STAGES

Pump stage	Internal variable	Input variables
0	Pump 1	0.0
1	Pump 2	DWTRT
2	Pump 3	WPUMP(1)+DWTRT
3	Pump 4	WPUMP(2)+DWTRT
4	Pump 5	WPUMP(3)+DWTRT
5	Pump 6	WPUMP(4)+DWTRT
6	Pump 7	WPUMP(5)+DWTRT

Storage volume switches can be used to simulate control of wet-weather pumps. The triggering volumes are a pair of input arrays, VOLON and VOLOFF, for each of the five stages. For a specific pump stage, the VOLOFF value must not be greater than the VOLON value. Also, the VOLON values must be increasingly larger in a similar fashion to values of WPUMP. As storage

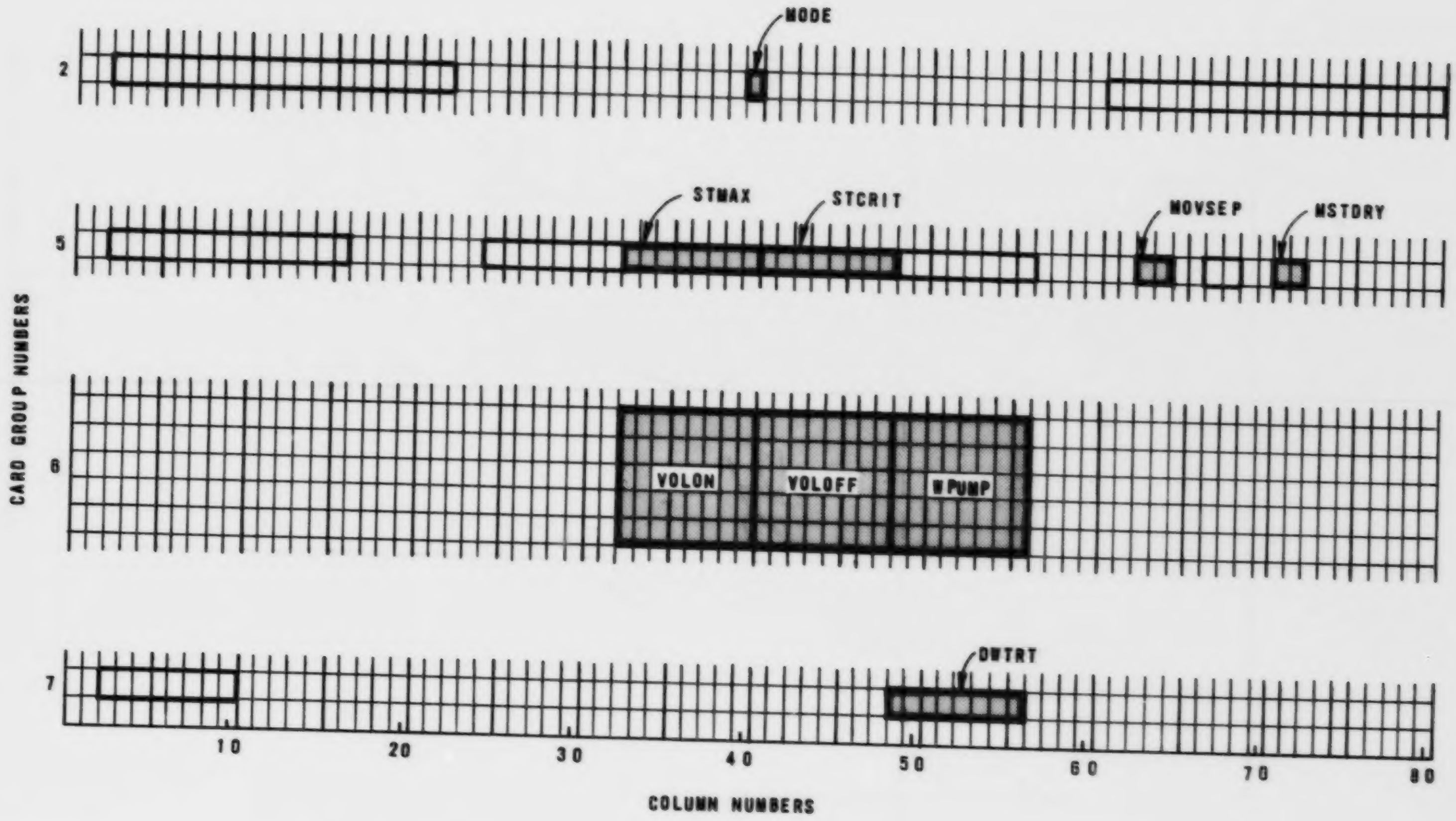
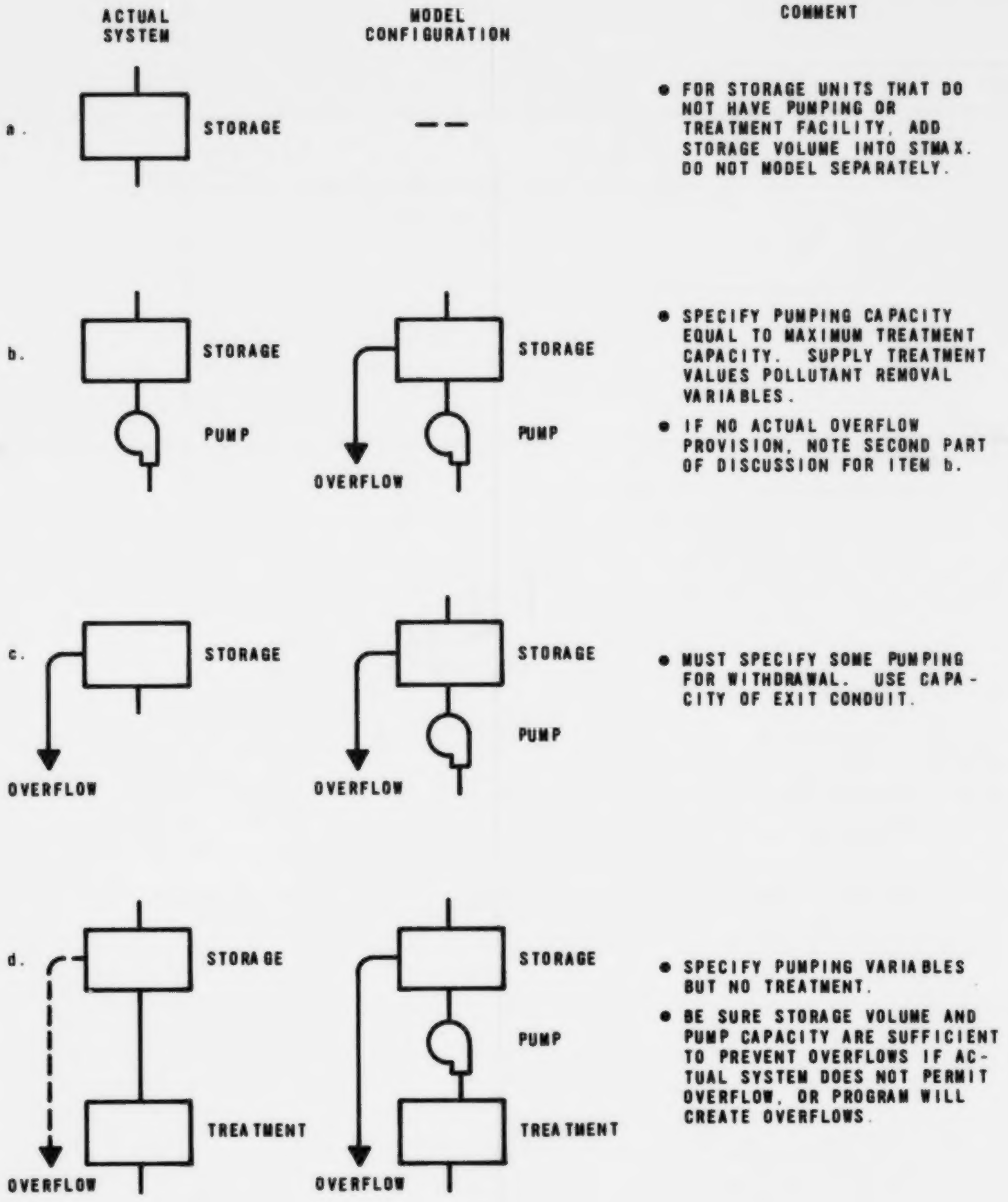


Figure 30. System physical characteristic variable format.



a.
- FOR STORAGE UNITS THAT DO NOT HAVE PUMPING OR TREATMENT FACILITY, ADD STORAGE VOLUME INTO STMAX. DO NOT MODEL SEPARATELY.

b.
- SPECIFY PUMPING CAPACITY EQUAL TO MAXIMUM TREATMENT CAPACITY. SUPPLY TREATMENT VALUES POLLUTANT REMOVAL VARIABLES.
- IF NO ACTUAL OVERFLOW PROVISION, NOTE SECOND PART OF DISCUSSION FOR ITEM b.

c.
- MUST SPECIFY SOME PUMPING FOR WITHDRAWAL. USE CAPACITY OF EXIT CONDUIT.

d.
- SPECIFY PUMPING VARIABLES BUT NO TREATMENT.
- BE SURE STORAGE VOLUME AND PUMP CAPACITY ARE SUFFICIENT TO PREVENT OVERFLOWS IF ACTUAL SYSTEM DOES NOT PERMIT OVERFLOW, OR PROGRAM WILL CREATE OVERFLOWS.

Figure 31. Storage configurations.

fills, the first value of VOLON is reached and the first wet-weather pump is activated. If the storage volume then drops past the level specified by first value of VOLOFF, the pump will be shut off. When storage continues to rise, as each value of VOLON is exceeded, the corresponding wet-weather pump stage is turned on. At the end of a storm event, each pump stage is turned off when the storage volume recedes below the associated value of VOLOFF.

Which of the system physical characteristic variables must be present in a EPAMAC run depends on the choice of variable MODE. MODE can be assigned one of three values: 0, 1, or 2. When MODE = 0, two variables, STMAX and DWTRT, and array WPUMP are used to process wastewater through the physical system. When MODE = 1, a variable STCRIT is also used besides variables STMAX and DWTRT and array WPUMP. When MODE = 2, variables STMAX and DWTRT and arrays WPUMP, VOLON, and VOLOFF are used to regulate wastewater flow. The interrelationships are explained in more detail in the following discussion of variable MODE. An example of the interrelationships are shown in Figure 32.

The operation of the pumps and the effect on storage volume is regulated by the variable MODE. When MODE = 0, the pump stage will be set each hour at the maximum level possible or at the maximum level required to reduce remaining storage volume to zero. This is the minimum flow delay option. All wastewater is processed at the highest rate possible. Variables STMAX DWTRT and array WPUMP are specified.

When MODE = 1, the minimum pumping level DWTRT will be used until critical storage is reached (STCRIT). For all hours when storage is greater than STCRIT, the wet-weather pumps are available. However, the program will choose the lowest pumping rate possible to prevent an immediate overflow. The effect of this pump operation is to keep storage as full as possible and maximize flow delay. Specify variables STMAX, DWTRT, and STCRIT and array WPUMP for this mode.

An additional variable MSTDRY, maximum flow delay, is used when MODE = 1 to reset the critical storage control procedure (STCRIT). MSTDRY is the minimum number of hours storage must be dry before use of wet-weather pump capacity is again subject to satisfying the critical storage volume condition. In effect, the use of MSTDRY defines the end of a storm pumping event, and takes the wet-weather pumps off line.

The third pump operation mode is specified by MODE = 2. The volume on/off switches are used to control pump operation in this case. If MODE is not input as 2, the variables VOLON and VOLOFF need not be specified. Variables required are STMAX and DWTRT along with arrays WPUMP, VOLON, and VOLOFF when MODE = 2.

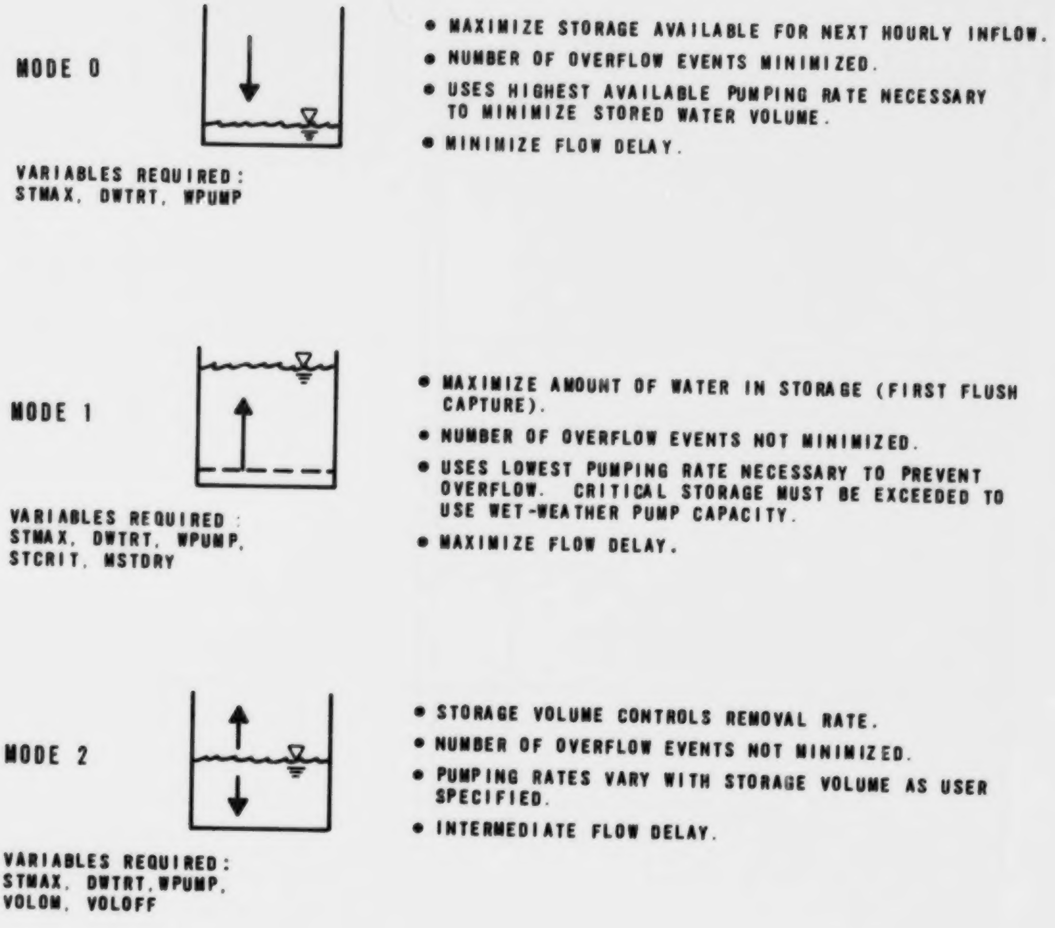

MODE 0
• MAXIMIZE STORAGE AVAILABLE FOR NEXT HOURLY INFLOW.
• NUMBER OF OVERFLOW EVENTS MINIMIZED.
• USES HIGHEST AVAILABLE PUMPING RATE NECESSARY TO MINIMIZE STORED WATER VOLUME.
• MINIMIZE FLOW DELAY.
VARIABLES REQUIRED: STMAX, DWTRT, WPUMP
MODE 1
• MAXIMIZE AMOUNT OF WATER IN STORAGE (FIRST FLUSH CAPTURE).
• NUMBER OF OVERFLOW EVENTS NOT MINIMIZED.
• USES LOWEST PUMPING RATE NECESSARY TO PREVENT OVERFLOW. CRITICAL STORAGE MUST BE EXCEEDED TO USE WET-WEATHER PUMP CAPACITY.
• MAXIMIZE FLOW DELAY.
VARIABLES REQUIRED: STMAX, DWTRT, WPUMP, STCRIT, MSTORY
MODE 2
• STORAGE VOLUME CONTROLS REMOVAL RATE.
• NUMBER OF OVERFLOW EVENTS NOT MINIMIZED.
• PUMPING RATES VARY WITH STORAGE VOLUME AS USER SPECIFIED.
• INTERMEDIATE FLOW DELAY.
VARIABLES REQUIRED: STMAX, DWTRT, WPUMP, VOLON, VOLOFF

Figure 32. Interrelationships of MODE, storage volume, and pumping rate.

The different pump operation modes will influence the number of overflows from the system. Mode zero will have the lowest number of overflows because the previous hour's wastewater volume is removed as quickly as possible. Mode 1 will have more overflows for identical storage and pumping configuration than mode zero because storage volume is kept higher. Mode 2 may have an intermediate number of overflows depending on pump configuration specified.

EPAMAC has three overflow event counters to keep track of the number of overflow events. The Type A overflow events are defined as all overflows separated by at least 1 hour of no overflow. Type B overflow events are overflows with no overflow the previous hour and empty storage. The Type C overflow event is similar to the Type A event except a user selected number of nonoverflow hours must occur before the event counter is reactivated. Variable MOVSEP specifies this minimum number of hours. When MOVSEP = 1, Types A and C events are identical. Figure 33 illustrates the different overflow event definitions.

As previously mentioned, selection of system physical characteristics will rely heavily on user judgment. If specific storage and pumping values are desired, EPAMAC application is straightforward. If the goal is an allowable overflow frequency, then an iterative procedure is required to arrive at ideal pumping and storage capacities. The user selects a set of system capacities and runs the model. The output number of overflows divided by the number of years of record will be the average overflow frequency for that set of system characteristics.

If the average overflow frequency is higher than the goal, the user should increase the pumping and/or storage capacity and re-run EPAMAC. If there is a limit on the maximum amount of storage that can be incorporated in the watershed, the user must be careful not to exceed that capacity and only use pumping to further reduce the overflow frequency.

If the overflow frequency obtained from an EPAMAC run is below the goal, the user should then decrease the system storage and/or pumping capacities. Again, if a specific storage volume exists, the user must not lower STMAX below that value or the EPAMAC runs will not accurately model the system (unless existing storage is to be removed). Three or four carefully selected runs are usually adequate to obtain system characteristics that yield the desired allowable overflow frequency.

Treatment Facilities--

Another category of input to EPAMAC is specification of wastewater treatment data. The user can select treatment data for either a conventional treatment facility or storage or both. For conventional treatment, input data can be specified as either

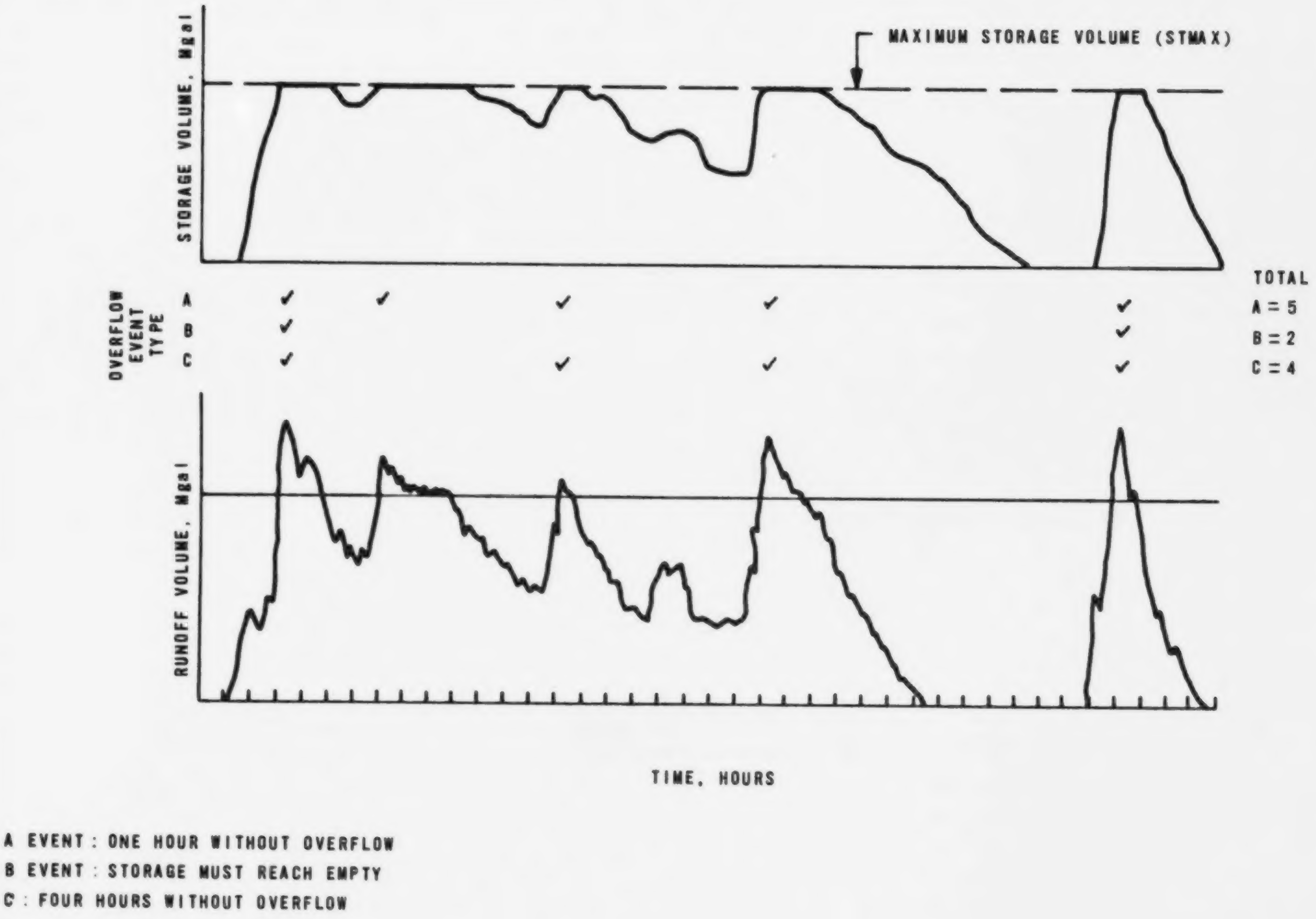


Figure 33. Overflow event definition examples.

percent removals or effluent concentrations. For storage facilities, input data are percent removals.

Sources of treatment efficiencies and effluent concentrations for conventional primary and secondary facilities can be estimated from text books or published data. Representative values can also be obtained from records of treatment facilities in the local area. Some typical percent removals are shown in Table 27. Pollutant removals in storage facilities are more difficult to estimate. Selection of treatment removals in storage is discussed in Appendix C.

Table 27. TYPICAL SEWAGE TREATMENT PROCESS EFFICIENCY RANGES [1]

Treatment operation or process	5-day, 20°C BOD	Removal of suspended solids
Fine screening	5-10	2-20
Chlorination of raw or settled sewage	15-30	--
Plain sedimentation	25-40	40-70
Chemical precipitation	50-85	70-90
Trickling filtration preceded and followed by plain sedimentation	50-95	50-92
Activated-sludge treatment preceded and followed by plain sedimentation	55-95	55-95
Stabilization ponds	90-95	85-95
Chlorination of biologically treated sewage	--	--

Five variables are involved in specification of conventional treatment data. The user has the option of specifying either a percent removal to be applied to the waste stream, or an effluent concentration. The variable ITREAT selects between the two options. ITREAT = 1 specifies percent removal. For ITREAT = 2, EPAMAC will use effluent concentrations. The treatment input variable locations are shown in Figure 34.

The variables REMTRB and REMTRS are the treatment percent removals of BOD and SS. Variables TRBC and TRSC are the treated effluent BOD and SS concentrations (mg/L). When ITREAT = 2, the user need only specify TRBC and TRSC. When ITREAT = 1, it is recommended that all four variables be input: REMTRB, REMTRS, TRBC, and TRSC. When ITREAT = 1, EPAMAC will compare the effluent quality derived from the percent removals against the treatment effluent concentrations. If the percent removal quality is below the effluent concentration quality for that treatment process, the values of TRBC and TRSC are used as the output quality.

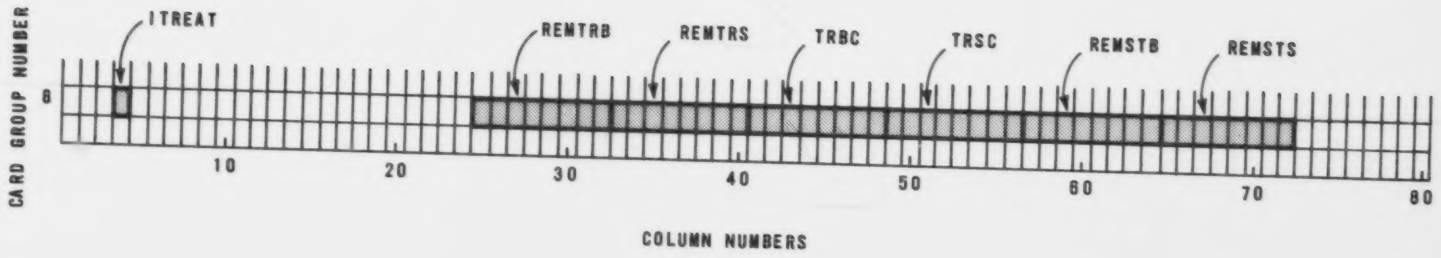


Figure 34. Treatment facility variable format.

The flow processed through treatment will be all flows pumped each hour. To model flow through separate dry- and wet-weather facilities, two runs are needed. The first run inputs a pumping capacity equal to the maximum dry-weather treatment capacity or interceptor capacity, whichever is appropriate. The overflow file from this first run is then input to a second run with pumping capacity equal to the wet-weather facility capacity (maximum-design or maximum-hydraulic capacity).

Treatment by storage facilities involves the use of variables REMSTB and REMSTS. These variables are percent removals of BOD and SS, respectively. The overflow quality is adjusted by the percent values and the removed load is left in storage. This method of handling storage treatment is useful when the user wants a general estimate of the magnitude of possible storage effects. A more detailed analysis of how to select REMSTB and REMSTS is presented in Appendix C.

File Handling and Output Parameters--

EPAMAC input variables dealing with the selection of file handling and output options are shown in Figure 35.

The first variables discussed are NIN, N1, N2, N3, N4, N5, N6, N7, and NTRAV. NIN and N1 through N7 are the logical unit numbers for identifying files on the computer system. NIN and N5 are used to specify the unit number for the input rain file.

If one rain file is used for all subareas in a run, assign the unit number to NIN and leave all N5 variables blank or zero. If each subarea has a different rain file, the NIN is overridden by all non-zero values of N5. For example, assume five subareas are being executed in a multiple EPAMAC run. Three of the areas use the same rain file on unit No. 12. The other areas have rain file defined as unit No. 21 and unit No. 23. Then, the first three files will have NIN = 12 and N5 = 0. The last two files will have N5 = 21 and N5 = 22, which overrides NIN = 12 for those two subareas.

The user should notice that if N5 or NIN are assigned, the rainfall data (Card Group 12) will be separate from all the other input data. Examples of rain data being included or excluded from the input data file can be seen in Figure 36. The second and third subareas have Card Group 11 as the last input because N5 is assigned. For the first subarea, however, Card Group 12 is present. When N5 and NIN are both zero, rainfall data must be placed immediately after Card Group 11.

N1 to N4 and NTRAV are associated with the lateral inflow files. As with variable N5, N1 through N4 are assigned the logical unit number of the input file, or left blank (zero) if not used. If any of the files are best represented by a time delay, then the

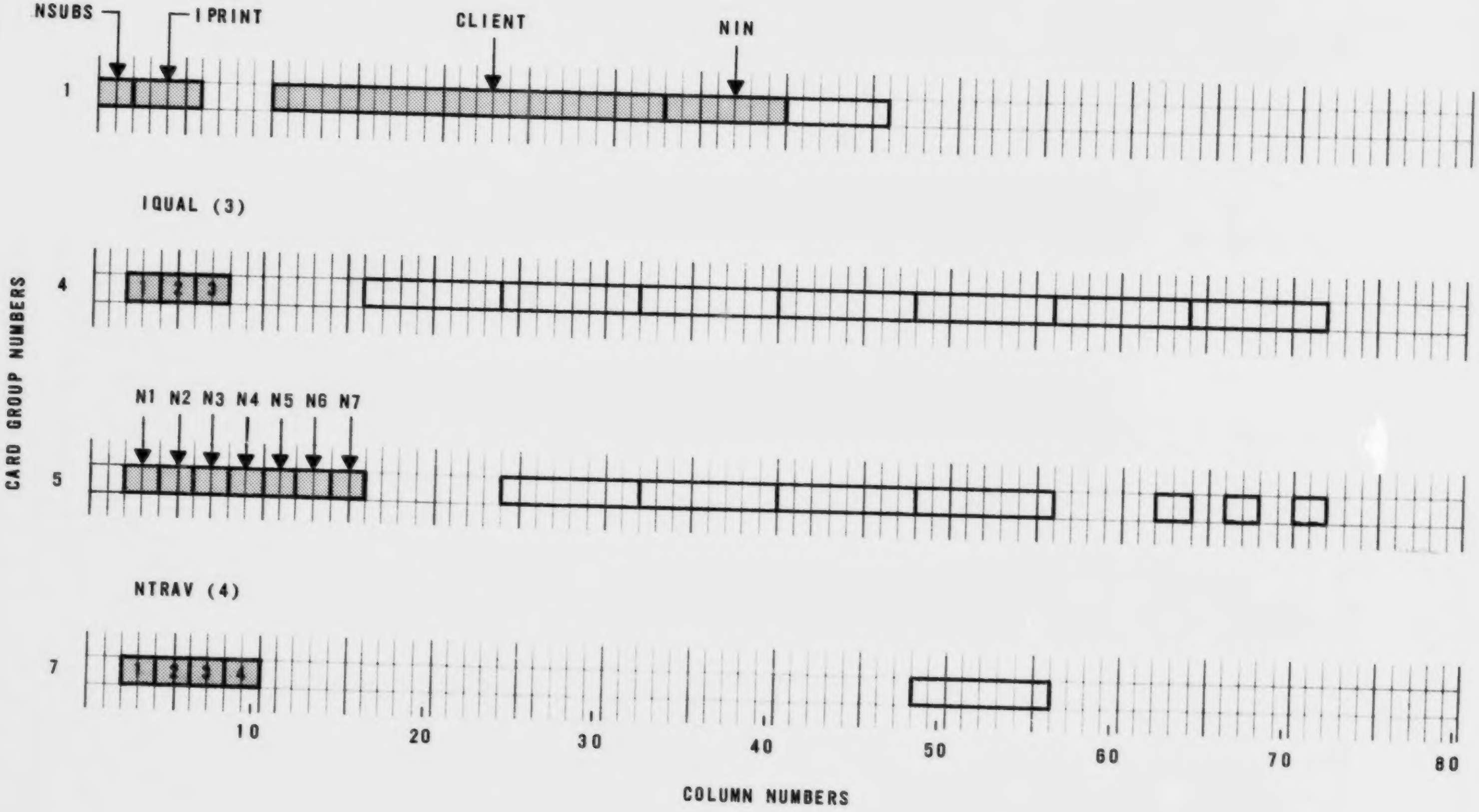
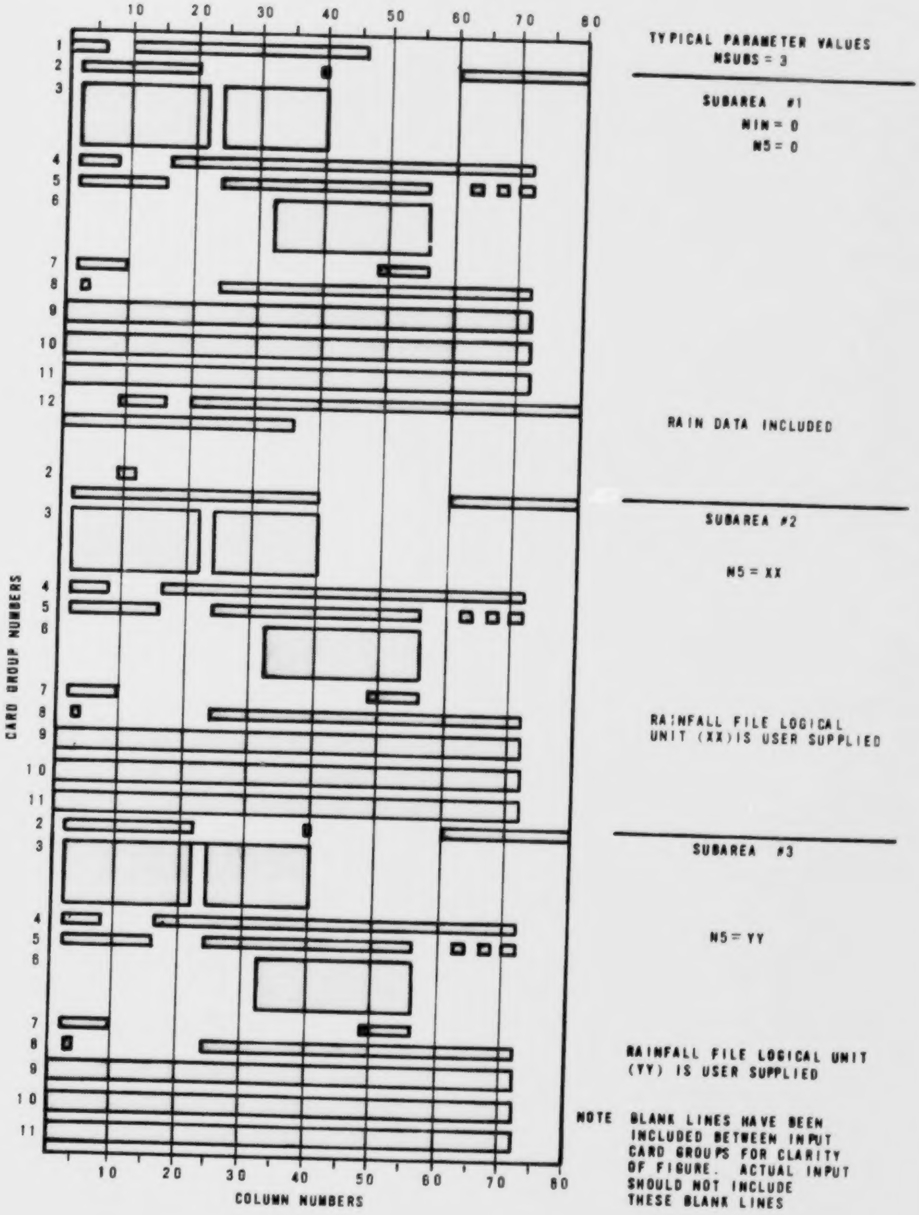


Figure 35. File handling and output parameter variable format.



NOTE BLANK LINES HAVE BEEN INCLUDED BETWEEN INPUT CARD GROUPS FOR CLARITY OF FIGURE. ACTUAL INPUT SHOULD NOT INCLUDE THESE BLANK LINES

Figure 36. Multiple run setup.

array NTRAV is specified. The appropriate travel time in whole hour increments is inserted in positions 1 through 4 to match with the lateral inflow file specification N1 through N4. The maximum value accepted in NTRAV is a 24-hour delay.

Variables N6 and N7 are for identification of logical unit numbers for treated (N6) and overflow (N7) files. If not used, these variables should be set to zero.

The remaining input variables to be chosen are CLIENT, NSUBS, and IPRINT, and array IQUAL.

CLIENT is the agency name. A maximum of 20 alphanumeric characters is allowed.

NSUBS is the number of subareas to be processed in the EPAMAC run. Several runs can be executed together by placing the input information for each, one after another, in a file. The first line, the global card, is only input once. The remaining lines 2 through 11 (or end of rain data) are the portion to be repeated for each subarea. An example of how three subareas might be combined in one multiple EPAMAC run is shown in Figure 36.

The variable IPRINT selects the printout option: hourly, daily, monthly, yearly, or subarea. A comparison of the volume of paper generated by the different choices was presented in Table 20. The values of IPRINT and the corresponding output options are shown in Table 28. The features of the output options are described in detail later in this section.

Table 28. PRINTOUT OPTIONS

IPRINT	Option
0 or 5	Subarea
1	Yearly
2	Monthly
3	Daily
4	Hourly

The array IQUAL determines the flow streams that have the pollutant values printed in the output. This section of the output has three pairs of columns, two in units of klb and one in mg/L. The user can choose runoff, overflow, or treated flow streams to be the output columns. Table 29 illustrates the corresponding flow streams and values of IQUAL. IQUAL will be discussed further in the Example Output discussion of this section.

Table 29. QUALITY PRINTOUT OPTIONS

IQUAL	Option
0	None, blank
1	Runoff
2	Overflow
3	Treated

Example Input

The input variables for EPAMAC have been outlined above and are presented sequentially in Table 30 with card groups highlighted. Three examples of input data are presented: (1) a base run, (2) combination run, and (3) split run.

The first example is a base run. The input deck is shown in Figure 37. From Card Group 1, it is known this is a single EPAMAC run with the daily print option. The rain file is logical unit 15, and the water year is defined as starting in July. The second line indicates the run is for subarea 8 with an alternative title of Seacliff-Richmond. In this example, an average runoff coefficient for the entire area is used rather than those for the individual land uses. The average runoff coefficient is 0.51 and the subarea contains 1,990 acres.

The next card group (4) presents the stormwater concentrations. A value of 0.025 inch (0.064 cm) of rainfall was selected to signal the transition back to first hour pollutant concentrations. The printout will contain runoff data in klb and overflow file information in klb and mg/L for both BOD and SS. In this example, the klb columns will be identical, as the overflow file is equivalent to the runoff file because no treatment or pumping is specified.

The fifth card group has information that the rain file is logical unit 15, and also informs the user that logical unit 21 will have the overflow output file written to it. In this example, specifying the unit number on Card Group 5 is not necessary as NIN of Card Group 1 has the same value.

There are no lateral inflow files. Note also that the rain factor is 1.2, implying the rain file is multiplied by 1.2 to match more closely what is expected in subarea 8. As no pumping or dry-weather treatment is specified, Card Groups 6 and 7 are blank (filled with zeros). Card Groups 8 and 9 are also blank, since treatment and dry-weather flow are not included in this base run.

Table 30. EPAMAC CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1			Run information card		
	I2	1-2	Number of subareas/run	NSUBS	None
	I4	3-6	Print control = 0,5 for subarea = 1 for yearly = 2 for monthly = 3 for daily = 4 for hourly	IPRINT	5
	6A4	11-34	Agency name	CLIENT	None
	I6	35-40	Unit assignment for rain input. This will be overridden by a non-zero value of N5 on card 6.	NIN	5
	I6	41-46	Water year starting month	MWTYR	MDATA
2			REPEAT CARDS 2-11 FOR EACH SUBAREA Watershed name card		
	5A4	3-22	Watershed name	WASHED	None
	I1	40	Storage operational mode = 0 for minimum flow delay = 1 for maximum flow delay without immediate overflow* = 2 for volume switch control (see Card Group 6)* *Minimum withdrawal rate = DWF treatment plant capacity.	MODE	None
	5A4	61-80	Alternative watershed name (appears on the output heading to the right of the main name).	WNAME	None
3			REPEAT CARD 3 FOR EACH OF 6 LAND USES Land use card		
	5A4	3-22	Land use name	AUSE	None
	F8.2	25-32	Runoff coefficient (also see Card Group 5)	ROK	None
	F8.3	33-40	Area, acres	AREA	None
4			Runoff quality card		
	I2	3-4	BOD & SS print option for 1st pair of columns, klb = 0 for blank = 1 for runoff = 2 for overflow = 3 for treated	IQUAL(1)	None
	I2	5-6	BOD & SS print option for 2nd pair of columns, klb (ditto)	IQUAL(2)	None
	I2	7-8	BOD & SS print option for 3rd pair of columns, mg/L (ditto)	IQUAL(3)	None
	F8.3	17-24	Minimum rainfall to reset pollutant concentrations in surface runoff.	RAINMN	None

NOTE: All nondecimal (I format) numbers must be right justified.

Table 30 (Continued)

Card group	Format	Card columns	Description	Variable name	Default value
4 cont.	F8.2	25-32	BOD concentration (mg/L) in 1st hour's runoff after MRODRY dry hours*	BCONC(1)	None
	F8.2	33-40	BOD concentration (mg/L) in 2nd hour's runoff*	BCONC(2)	None
	F8.2	41-48	BOD concentration (mg/L) all subsequent hours' runoff*	BCONC(3)	None
	F8.2	49-56	SS concentration (mg/L) in 1st hour's runoff after MRODRY dry hours*	SCONC(1)	None
	F8.2	57-64	SS concentration (mg/L) in 2nd hour's runoff*	SCONC(2)	None
	F8.2	65-72	SS concentration (mg/L) all subsequent hours' runoff*	SCONC(3)	None
			*Note: The runoff concentration is only changed to the following value when the previous hour's rain exceeded RAINMN.		
5			Unit assignment and storage card		
	I2	3-4	Unit assignment for 1st lateral inflow input file	N1	None
	I2	5-6	Unit assignment for 2nd lateral inflow input file	N2	None
	I2	7-8	Unit assignment for 3rd lateral inflow input file	N3	None
	I2	9-10	Unit assignment for 4th lateral inflow input file	N4	None
	I2	11-12	Unit assignment for rain input file	N5	NIN or 5
	I2	13-14	Unit assignment for storage withdrawal output file	N6	None
	I2	15-16	Unit assignment for storage overflow output file	N7	None
	F8.2	25-32	Override runoff coefficient (if nonzero)	AKOVER	None
	F8.2	33-40	Maximum storage capacity, Mgal	STMAX	None
	F8.2	41-48	Critical storage capacity, Mgal. (Only applicable when storage operational MODE = 1 on Card Group 2, i.e., for maximum flow delay. Then withdrawal pumps cannot start until this critical storage has been filled.)	STCRIT	None
	F8.2	49-56	Rain factor. (Used rainfall = input rainfall multiplied by rain factor.)	RFAC	None
	I2	63-64	Minimum hours of separation between overflow events	MOVSEP	None
	I2	67-68	Minimum dry period for runoff definition	MRODRY	1.0
	I2	71-72	Minimum number of preceding dry hours. (Only applicable when storage operational MODE = 1 on Card Group 2, i.e., for maximum flow delay. Then, this dry period is required to trigger the critical storage requirement specified in Columns 41-48 above.)	MSTDRY	None

Table 30 (Continued)

Card group	Format	Card columns	Description	Variable name	Default value
			REPEAT CARD 6 FOR EACH OF 5 WET-WEATHER PUMP STAGES (Arrange numerical values in descending order)		
6			Pump stage card		
	F8.2	33-40	Pump on switch*, Mgal	VOLON	None
	F8.2	41-48	Pump off switch*, Mgal	VOLOFF	None
	F8.2	49-56	Pumped withdrawal rate of all wet-weather pumps in operation at this stage, Mgal/d	WPUMP	None
			*Note: Pump switches are only required for storage operational MODE = 2 on Card Group 2.		
7			Routing and dry-weather treatment card		
	I2	3-4	Time delay in transport for lateral inflow N1, hours (must be in the range 0-24)	NTRAV(1)	None
	I2	5-6	Time delay in transport for lateral inflow N2, hours (must be in the range 0-24)	NTRAV(2)	None
	I2	7-8	Time delay in transport for lateral inflow N3, hours (must be in the range 0-24)	NTRAV(3)	None
	I2	9-10	Time delay in transport for lateral inflow N4, hours (must be in the range 0-24)	NTRAV(4)	None
	F8.2	49-56	DWF treatment capacity, Mgal/d	DWTRT	None
8			Treatment efficiency card		
	I1	4	Treatment option = 1 to specify BOD & SS removal efficiencies = 2 to specify BOD & SS concentrations in effluent	ITREAT	None
	F8.2	25-32	BOD removal efficiency, %	REMTRB	None
	F8.2	33-40	SS removal efficiency, %	REMTRS	None
	F8.2	41-48	Maximum BOD concentration in treated effluent, mg/L	TRBC	None
	F8.2	49-56	Maximum SS concentration in treated effluent, mg/L	TRSC	None
			*Note: Only one pair of the above four values is required, depending upon the treatment option specified.		
	F8.2	57-64	BOD removal efficiency, % from storage	REMSTB	None
	F8.2	65-72	SS removal efficiency, % from storage	REMSTS	None

Table 30 (Concluded)

Card group	Format	Card columns	Description	Variable name	Default value
			REPEAT CARD 9 TWICE (FOR AM & PM)		
9			Dry-weather hydrograph card		
	12F6.3	1-72 (by 6)	Twelve hourly dry-weather flows, Mgal/h	DWF	None
			REPEAT CARD 10 TWICE (FOR AM & PM)		
10			Dry-weather BOD card		
	12F6.3	1-72 (by 6)	Twelve hourly dry-weather BOD loads, klb/h	DWFB	None
			REPEAT CARD 11 TWICE (FOR AM & PM)		
11			Dry-weather SS card		
	12F6.3	1-72 (by 6)	Twelve hourly dry-weather SS loads, klb/h	DWFS	None
			INCLUDE CARD 12 FOR EVERY DAY WITH RAIN, BUT ONLY IF BOTH NIN & N5 = 0 or 5 (see Card Groups 1 and 5).		
12			Rain data card		
	13	10-12	Year	YDATA	None
	12	13-14	Month	MDATA	None
	12	15-16	Day	DDATA	None
	24F4.2	21-116 (by 4)	Twenty-four hourly rainfalls, in hundredths of an inch (may be input as integers).	RAIN	None
			Note: The end of the rain data must be signified by a card with 99 in columns 11-12.		

The second example is a combination run. The input data are presented in Figure 38. There are several differences between this example and the previous one. The most important differences are the exclusion of a runoff coefficient and the inclusion of pumping and dry-weather data.

Notice that the output file from example 1 is an input (lateral inflow) file. Overflow and treated data are to be printed. Other data specified are: storage of 57.3 Mgal (216,900 m^3), total wet-weather pumping capacity of 80 Mgal/d (3.5 m^3/s) in two stages, 50 Mgal/d (2.2 m^3/s)dry-weather pumping, and no treatment. Dry-weather flows and concentrations are also included. Note that two of the lateral inflow files have been delayed 1 hour.

```
                                 DATA                                                   CARD GROUP
                                                                                          NUMBER
//EPATEST1 JOB E43$XX,'MARIANNE',TIME=(,10)                                             JOB CONTROL
/*JOBPARM BIN=322,HOLD=OUTPUT,FORMS=1181,LINES=10                                       JOB CONTROL
// EXEC FORTG                                                                           JOB CONTROL
//GO.SYSLIN DD DSN=WYL.XX.E43.OBJ.EPAMAC,                                               JOB CONTROL
//          UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                                    JOB CONTROL
//GO.FT15F001 DD DSN=WYL.XX.E43.EPA.RAIN.LIB(AREA05),                                   JOB CONTROL
//          UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP),LABEL=(,,,IN)                      JOB CONTROL
//GO.FT21F001 DD DSN=WYL.XX.E43.EPABASE.AREA08,                                         JOB CONTROL
//          UNIT=DISK,VOL=SER=PUB003,DISP=(NEW,KEEP),                                   JOB CONTROL
//          DCB=(RECFM=VBS,BLKSIZE=6233),SPACE=(TRK,(10,5),RLSE)                        JOB CONTROL
//GO.SYSIN DD *                                                                         JOB CONTROL
  1   3    U.S.E.P.A.                            15     7                                    1
   SUBAREA BASE RUN 8                             0                                          2
   TOTAL AREA             .51     1990.                        SEACLIFF-RICHMOND             3
                                                                                             3
                                                                                             3
                                                                                             3
                                                                                             3
                                                                                             3
   1 2 2         0.025    136.0   71.0    32.0    281.0   214.0    127.0                     4
   0 0 0 015 021          0.0     00.0    0.0     1.2             12    6    0               5
                                  0.0     0.0     00.0                                       6
                                  0.0     0.0     0.0                                        6
                                  0.0     0.0     0.0                                        6
                                  0.0     0.0     0.0                                        6
                                  0.0     0.0     0.0                                        6
   0 0 0 0                                        00.0                                       7
   1                     0.0      0.0     0.0     0.0     0.0     0.0                        8
0.0                                                                                          9
0.0                                                                                          9
0.0                                                                                          10
0.0                                                                                          10
0.0                                                                                          11
0.0                                                                                          11
/*                                                                                      JOB CONTROL
```

Figure 37. Base run input data example.

```
                                   DATA                                                     CARD GROUP
                                                                                              NUMBER
//EPATEST1 JOB E43$XX,'MARIANNE',TIME=(,10)                                               JOB CONTROL
/*JOBPARM BIN=322,HOLD=OUTPUT,FORMS=1181,LINES=10                                         JOB CONTROL
// EXEC FORTG                                                                             JOB CONTROL
//GO.SYSLIN DD DSN=WYL.XX.E43.OBJ.EPAMAC,                                                 JOB CONTROL
//           UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                                     JOB CONTROL
//GO.FT11F001 DD DSN=WYL.XX.E43.EPABASE.AREA08,                                           JOB CONTROL
//             UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                                   JOB CONTROL
//GO.FT12F001 DD DSN=WYL.XX.E43.EPACOMB.WST,                                              JOB CONTROL
//             UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                                   JOB CONTROL
//GO.FT13F001 DD DSN=WYL.XX.E43.EPACOMB.UV,                                               JOB CONTROL
//             UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                                   JOB CONTROL
//GO.FT14F001 DD DSN=WYL.XX.E43.EPA.RAIN.LIB(AREA05),                                     JOB CONTROL
//             UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP),LABEL=(,,,IN)                     JOB CONTROL
//GO.FT21F001 DD DSN=WYL.XX.E43.EPARUN.WEST15TR,                                          JOB CONTROL
//            UNIT=DISK,VOL=SER=PUB003,DISP=(NEW,KEEP),                                   JOB CONTROL
//            DCB=(RECFM=VBS,BLKSIZE=6233),SPACE=(TRK,(10,5),RLSE)                        JOB CONTROL
//GO.FT22F001 DD DSN=WYL.XX.E43.EPARUN.WEST15OV,                                          JOB CONTROL
//            UNIT=DISK,VOL=SER=PUB003,DISP=(NEW,KEEP),                                   JOB CONTROL
//            DCB=(RECFM=VBS,BLKSIZE=6233),SPACE=(TRK,(10,5),RLSE)                        JOB CONTROL
//GO.SYSIN DD *                                                                           JOB CONTROL
 1   2    U.S.E.P.A.                        0     7                                            1
  WEST SIDE SF                              0                   ALTERNATIVE 15                 2
  AREAS 1 TO 8           .00     2189.                                                         3
                                                                                               3
                                                                                               3
                                                                                               3
                                                                                               3
                                                                                               3
  3 2 2          0.025   136.0    71.0     32.0     281.0    214.0    127.0                    4
  111213 0142122         0.0      57.3     0.0      1.0              12    6    0              5
                                  0.0      0.0      80.0                                       6
                                  0.0      0.0      50.0                                       6
                                  0.0      0.0      0.0                                        6
                                  0.0      0.0      0.0                                        6
                                  0.0      0.0      0.0                                        6
   1 0 1 0                                          50.0                                       7
   1                     0.0      0.0      0.0      0.0      0.0      0.0                      8
0.66  0.49  0.40  0.35  0.33  0.33  0.48  0.89  1.13  1.24  1.29  1.24                         9
1.15  1.06  0.98  0.94  0.93  0.97  1.07  1.13  1.10  1.03  0.95  0.84                         9
0.89  0.42  0.29  0.23  0.16  0.16  0.60  1.32  2.26  2.70  2.39  2.19                        10
2.01  1.98  1.55  1.50  1.49  1.67  1.93  2.16  2.10  2.12  1.58  1.22                        10
0.67  0.33  0.24  0.15  0.13  0.14  0.29  1.61  2.73  3.29  3.07  2.17                        11
2.13  1.84  1.58  1.38  1.22  1.46  1.71  2.03  2.07  1.89  1.40  1.02                        11
/*                                                                                        JOB CONTROL
```

Figure 38. Combination run input data example.

The stormwater concentrations and area are extraneous information in this combining run although they were left in the file. The information is printed out in the introductory pages of the printout to aid identification of the assumptions used in developing this EPAMAC run at a later time.

The input data for the third example, a split run, are shown in Figure 39. The treated file from Example 2 is run through dry-weather pumping and treatment to separate out the dry- and wet-weather portions. Notice in Figure 39 that no dry-weather data are included from Card Groups 9, 10, or 11. This information was incorporated in the previous run and should not be duplicated here.

The last example is a portion of the rain file for the subarea run. The file is shown in Figure 40. In this case, a string of 9's was placed to signal the end of file although only three are required, in columns 10-12.

Example Output

The variables involved with selecting certain aspects of the printout were discussed earlier. Those features as well as the rest of the output is now described in more detail. The output of EPAMAC consists of three categories: (1) the input data summary, (2) the main program printout, and (3) results summary. The input data summary is five pages long and essentially repeats the selected input data. Examination of these pages will help to identify input errors and aids in identification of the run later. The main program printout varies in length depending on choice of variable IPRINT. The statistical result summary is one page in length.

Input Data Summary--

The first page of the input data summary contains a banner explaining development of the EPAMAC model and repeats global input variables. The remaining pages in the introductory section repeat the remaining input data. The data are grouped and tabulated by topic. Variables are drawn together to aid in grasping the interrelationships. The topic categories are: land use characteristics, storage and pump capacities, wet-weather flow, dry-weather flow, treatment, input/output files, storage operating mode, quality print options, and assorted definitions. An example of the 5 pages of input data summary is shown in Figure 41. The exact form of the introductory printout will vary a little depending on the chosen options.

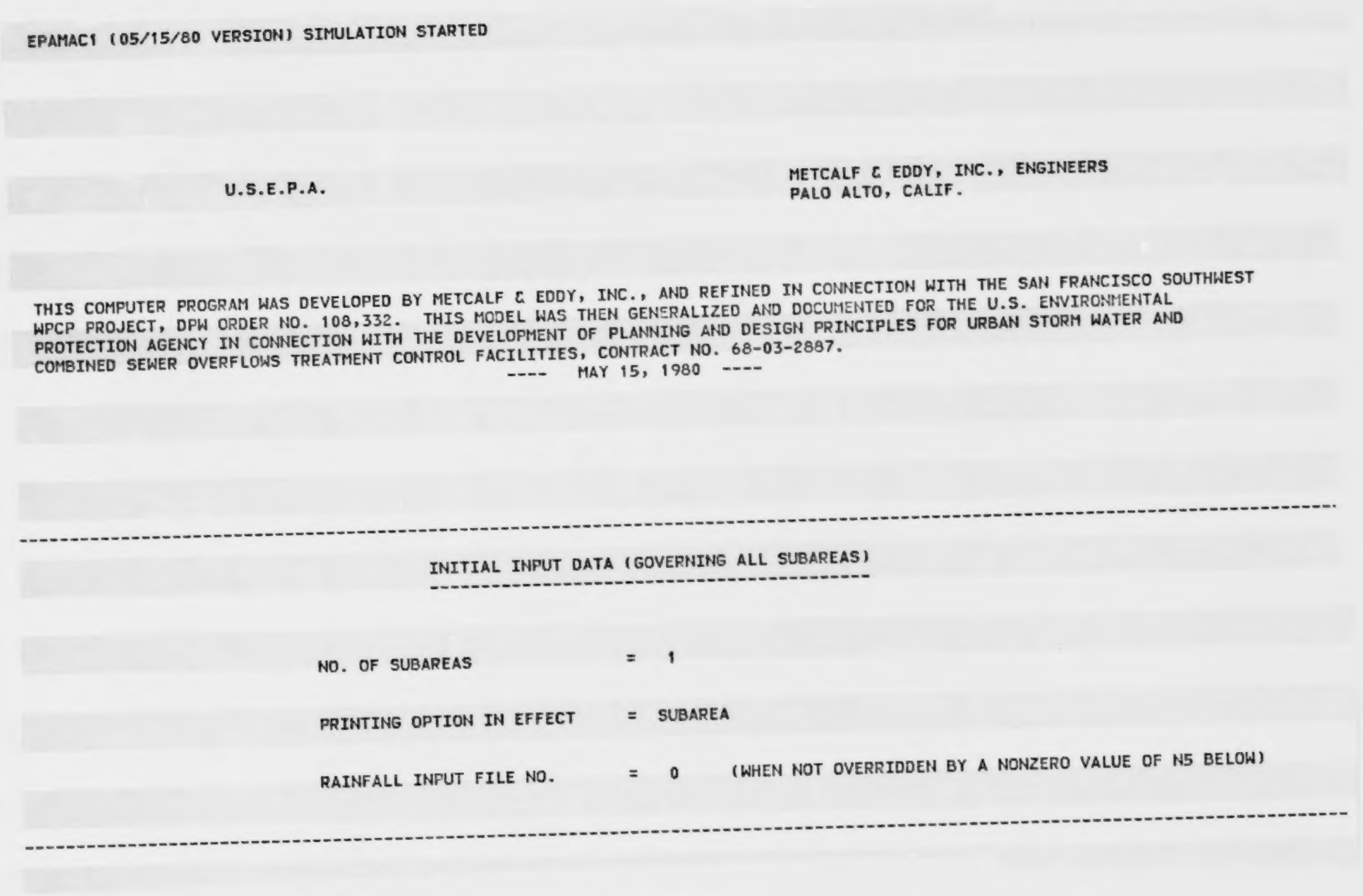
```
                                   DATA                                         CARD GROUP
                                                                                  NUMBER

//EPATEST1 JOB E43$XX,'MARIANNE',TIME=(,10)                                   JOB CONTROL
/*JOBPARM BIN=322,HOLD=OUTPUT,FORMS=1181,LINES=10                             JOB CONTROL
// EXEC FORTG                                                                 JOB CONTROL
//GO.SYSLIN DD DSN=WYL.XX.E43.OBJ.EPAMAC,                                     JOB CONTROL
//          UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                          JOB CONTROL
//GO.FT11F001 DD DSN=WYL.XX.E43.EPARUN.WEST15TR,                              JOB CONTROL
//            UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP)                        JOB CONTROL
//GO.FT15F001 DD DSN=WYL.XX.E43.EPA.RAIN.LIB(AREA05),                         JOB CONTROL
//            UNIT=DISK,VOL=SER=PUB003,DISP=(OLD,KEEP),LABEL=(,,,IN)          JOB CONTROL
//GO.FT31F001 DD DSN=WYL.XX.E43.EPASPLT.WEST15TR.DW,                          JOB CONTROL
//            UNIT=DISK,VOL=SER=PUB003,DISP=(NEW,KEEP),                       JOB CONTROL
//            DCB=(RECFM=VBS,BLKSIZE=6233),SPACE=(TRK,(10,5),RLSE)            JOB CONTROL
//GO.FT32F001 DD DSN=WYL.XX.E43.EPASPLT.WEST15TR.WW,                          JOB CONTROL
//            UNIT=DISK,DISP=(NEW,KEEP),VOL=SER=PUB003,                       JOB CONTROL
//            DCB=(RECFM=VBS,BLKSIZE=6233),SPACE=(TRK,(10,5),RLSE)            JOB CONTROL
//GO.SYSIN DD *                                                               JOB CONTROL
 1   1    U.S.E.P.A.                         0     7                               1
  WEST SIDE SF                               0                                     2
  AREAS 1 TO 8          .00      2189.                     DW/WW  SPLIT            3
                                                                                   3
                                                                                   3
                                                                                   3
                                                                                   3
                                                                                   3
   2 3 3       0.025    136.0    71.0    32.0    281.0    214.0    127.0           4
  11 0 0 0153132        0.0      00.0    0.0     1.0         12    6    0          5
                                 0.0     0.0     0.0                               6
                                 0.0     0.0     0.0                               6
                                 0.0     0.0     0.0                               6
                                 0.0     0.0     0.0                               6
                                 0.0     0.0     0.0                               6
   0 0 0 0                                       50.0                              7
   1                    60.0     30.0    30.0    30.0     0.0      0.0             8
0.0                                                                                9
0.0                                                                                9
0.0                                                                               10
0.0                                                                               10
0.0                                                                               11
0.0                                                                               11
/*                                                                            JOB CONTROL
```

Figure 39. Split run input data example.

```
          7210 2       7   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          7210 9       0   0   0   0   0   0   3   0  18   4  16  20  13   2   0   0   0   0   0   0   0   0   0   0
          721010       0   0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   2   0
          721011       4  16  49   7   2   0   0   1   1   7   2   5   6  10   0   1   0   0   0   0   0   0   0   0
          721012       0   4  29   2   2   2   0   0   6   8   0   0  26  13   1   0   1   0   0   0   0   0   0   0
          721013       0   0   0   0   0   0   0   0   0   0   0   0  17   6   0   0   0   0   0   0   0   0   0   0
          721014       0   0   2   2   9   8   2   0   0   0   2   1   1   0  19  18   2   6   3   2   6   7   3  28
          721015       0   0   1   8   5   0   2   1   0   0   0   2   0   0   0   0   0   0   0   0   0   0   0   0
          721016       0   0   0   1   0   0   0   1   0   1   0   1   0   0   2  20   3  11  19   0   0   0   0   0
          721017       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          7211 2       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          7211 3       0   0   0   0   0   1   0  15   1   0   1   0   1   8   6   3  12  13   3   0  10  14  29   9
          7211 4       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          7211 7       0   0   0   7   0   5   0   0   0   0   0   2   0   0   0   0   0   0   0   0   0   0   0   0
          7211 9       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   4   2   1   9   2   3   1   4  12
          721110      27  26   1   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1   0  11   3  25   7   0
          721111       1   2   1   3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          721112       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          721113       0   0   5   7   6   5   6  12   9  11  11   8   7  11   8   0   1   1   2   4  15  16  46   8
          721114       6   0   0   0   0   0   0   0   0   0   0   1   0   1   0   0   0   1   0   0   0   0   0   0
          721115       0   1   0   0   0   0   0   0   0   0   2   8   7   5   2  19   6   0   0   0   2   0   2   0
          721116       0   2   0   0   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0
          721118       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
          721119       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
99999999999999999999999999999999999999999999999
```

Figure 40. Rainfall input example.



```
EPAMAC1 (05/15/80 VERSION) SIMULATION STARTED


                 U.S.E.P.A.                                    METCALF & EDDY, INC., ENGINEERS
                                                               PALO ALTO, CALIF.


THIS COMPUTER PROGRAM WAS DEVELOPED BY METCALF & EDDY, INC., AND REFINED IN CONNECTION WITH THE SAN FRANCISCO SOUTHWEST
WPCP PROJECT, DPW ORDER NO. 108,332.  THIS MODEL WAS THEN GENERALIZED AND DOCUMENTED FOR THE U.S. ENVIRONMENTAL
PROTECTION AGENCY IN CONNECTION WITH THE DEVELOPMENT OF PLANNING AND DESIGN PRINCIPLES FOR URBAN STORM WATER AND
COMBINED SEWER OVERFLOWS TREATMENT CONTROL FACILITIES, CONTRACT NO. 68-03-2887.
                                    ----   MAY 15, 1980  ----



------------------------------------------------------------------------------------------------------------------------
                               INITIAL INPUT DATA (GOVERNING ALL SUBAREAS)
                               -------------------------------------------


                    NO. OF SUBAREAS              =   1

                    PRINTING OPTION IN EFFECT    =  SUBAREA

                    RAINFALL INPUT FILE NO.      =   0     (WHEN NOT OVERRIDDEN BY A NONZERO VALUE OF N5 BELOW)

------------------------------------------------------------------------------------------------------------------------
```

Figure 41. Input data summary output.

```
------------------------------------------------------------------------------------------------------

                          SUBAREA NUMBER  1:    WEST SIDE SF           EPA    TESTO
                          ------------------------------------------------------------------

LAND USE CHARACTERISTICS:

                                   ------------------------------------------------
                                                            AREA
                                           LAND USE         ACRES    K-FACTOR
                                       --------------------  -------  --------

                                       AREAS 1 TO 8          2189.     0.0
                                                                0.     0.0
                                                                0.     0.0
                                                                0.     0.0
                                                                0.     0.0
                                                                0.     0.0

                                       --------------------  -------  --------

                                       TOTAL                 2189.
                                       WEIGHTED AVERAGE                0.0
                                       OVERRIDE                        0.0
                                       GOVERNING                       0.0
                                   ------------------------------------------------


STORAGE AND PUMP CAPACITIES:

                          ---------------------------------------------------------------
                           S T O R A G E  (MGAL)                PUMP CAPACITIES (MGAL/D)
                          ------------------------  PUMP   ---------------------------
                          MAXIMUM   PUMP  CONTROLS           WET      DRY       TOTAL
                          STORAGE   --------------  STAGE  WEATHER  WEATHER  WITHDRAWAL
                          CAPACITY    ON     OFF                                RATE
                          --------  ------  ------  -----  -------  -------  ----------

                             57.3     0.0     0.0     6      80.0     50.0     130.00
                                      0.0     0.0     5       0.0     50.0      50.00
                                      0.0     0.0     4       0.0     50.0      50.00
                                      0.0     0.0     3       0.0     50.0      50.00
                                      0.0     0.0     2       0.0     50.0      50.00
                                                      1       0.0     50.0      50.00

                          ---------------------------------------------------------------
```

Figure 41 (continued)

```
WET WEATHER FLOW:

                              RAINFALL FACTOR = 1.00

                         ----------------------------------------
                          POLLUTANT CONCENTRATION IN SURFACE RUNOFF
                         ----------------------------------------

                            HOUR:           1        2       3+

                            BOD (MG/L)  136.00    71.00    32.00
                            SS  (MG/L)  281.00   214.00   127.00

                         ----------------------------------------

                          DRY PERIOD FOR RUNOFF EVENT DEFINITION =  6

                          MINIMUM RAINFALL TO RESET POLLUTANT
                          CONCENTRATIONS IN SURFACE RUNOFF =     0.025


DRY WEATHER FLOW:

  ----------------------------------------------------------------------------------------------------------------------

  HOUR                         1        2        3        4        5        6        7        8        9       10       11       12

  AM DWF (MGAL/H)           0.66     0.49     0.40     0.35     0.33     0.33     0.48     0.89     1.13     1.24     1.29     1.24
  PM DWF (MGAL/H)           1.15     1.06     0.98     0.94     0.93     0.97     1.07     1.13     1.10     1.03     0.95     0.84

  AM DWF BOD (KLB/H)        0.89     0.42     0.29     0.23     0.16     0.16     0.60     1.32     2.26     2.70     2.39     2.19
  PM DWF BOD (KLB/H)        2.01     1.98     1.55     1.50     1.49     1.67     1.93     2.16     2.10     2.12     1.58     1.22

  AM DWF SS  (KLB/H)        0.67     0.33     0.24     0.15     0.13     0.14     0.29     1.61     2.73     3.29     3.07     2.17
  PM DWF SS  (KLB/H)        2.13     1.84     1.58     1.38     1.22     1.46     1.71     2.03     2.07     1.89     1.40     1.02

  AM DWF BOD (MG/L)       161.59   102.71    86.88    78.75    58.10    58.10   149.79   177.73   239.66   260.92   222.01   211.64
  PM DWF BOD (MG/L)       209.45   223.84   189.53   191.22   191.99   206.31   216.15   229.06   228.77   246.64   199.30   174.04

  AM DWF SS  (MG/L)       121.65    80.70    71.90    51.36    47.21    50.84    72.40   216.78   289.51   317.94   285.18   209.71
  PM DWF SS  (MG/L)       221.95   208.01   193.20   175.92   157.20   180.37   191.51   215.27   225.50   219.89   176.59   145.51

  ----------------------------------------------------------------------------------------------------------------------


                 DWF                     FLOW              BOD              SS
                                    -------------   -------------   -------------
                                     MGD     MGH    KLB/D   KLB/H   KLB/D   KLB/H
         ------------------------   ------  ------  ------  ------  ------  ------

         TREATMENT CAPACITY (PS 1)   50.00   2.083
         PEAK FLOWRATE               30.96   1.290   64.80   2.700   78.96   3.290
         DAILY TOTAL                 20.98           34.92           34.55

         ------------------------   ------  ------  ------  ------  ------  ------
```

Figure 41 (continued)

```
TREATMENT:

                              TREATMENT OPTION = 1

                            ------------------------------
                             REMOVAL EFFICIENCY, %
                             ---------------------
                                 BOD       SS
                                 ---       --

                                 0.0       0.0

                            ------------------------------


INPUT/OUTPUT FILES:

                    SUMMARY OF I/O FILE NUMBERS:
                                 -----------------------------
                                  N1  N2  N3  N4  N5  N6  N7
                                  11  12  13   0  15   0   0
                                 -----------------------------

                    RAIN INPUT FILE:

                                 -----------------------
                                  FILE NAME          N5
                                  FILE NUMBER        15
                                 -----------------------

                    LATERAL INFLOW INPUT FILES, & FLOW ROUTING:

                                 ------------------------------------
                                  FILE NAME          N1  N2  N3  N4
                                  FILE NUMBER        11  12  13   0
                                  TIME DELAY, HR.     1   0   1   0
                                 ------------------------------------

                    OUTFLOW OUTPUT FILES:

                                 ------------------------------------
                                  OUTFLOW TYPE     PUMPED    OVERFLOW
                                  FILE NAME          N6         N7
                                  FILE NUMBER         0          0
                                 ------------------------------------
```

Figure 41 (continued)

```
STORAGE OPERATING MODE:

                                        MODE = 0 = MINIMUM FLOW DELAY

                                        ------------------------------
                                         STORAGE REMOVAL EFFICIENCY %
                                            ----------------------
                                              BOD        SS
                                              ---        --

                                              0.0        0.0

                                        ------------------------------


QUALITY PRINT OPTIONS SELECTED:

                               ---------------------------------------------------------
                               COLUMNS           1-2              3-4             5-6
                               UNITS             KLB              KLB             MG/L
                               VARIABLE      3 = TREATED     2 = OVERFLOW    2 = OVERFLOW
                               ---------------------------------------------------------


    WATER YEAR STARTING MONTH DEFINITION =  7


    DATE OF FIRST RAIN DATA CARD IS 10/ 2/ 72


    OVERFLOW TYPE DEFINITIONS:

        TYPE A:  ENDS AT FIRST HOUR WITHOUT OVERFLOW.

        TYPE B:  ENDS AT FIRST HOUR WITHOUT OVERFLOW PROVIDED WITHDRAWAL PUMP STAGE
                 IS ALSO LESS THAN 2 (IE, STORAGE IS EMPTY)

        TYPE C:  ENDS AFTER 12 HOURS WITHOUT OVERFLOW
```

Figure 41 (concluded)

Main Program Printout--

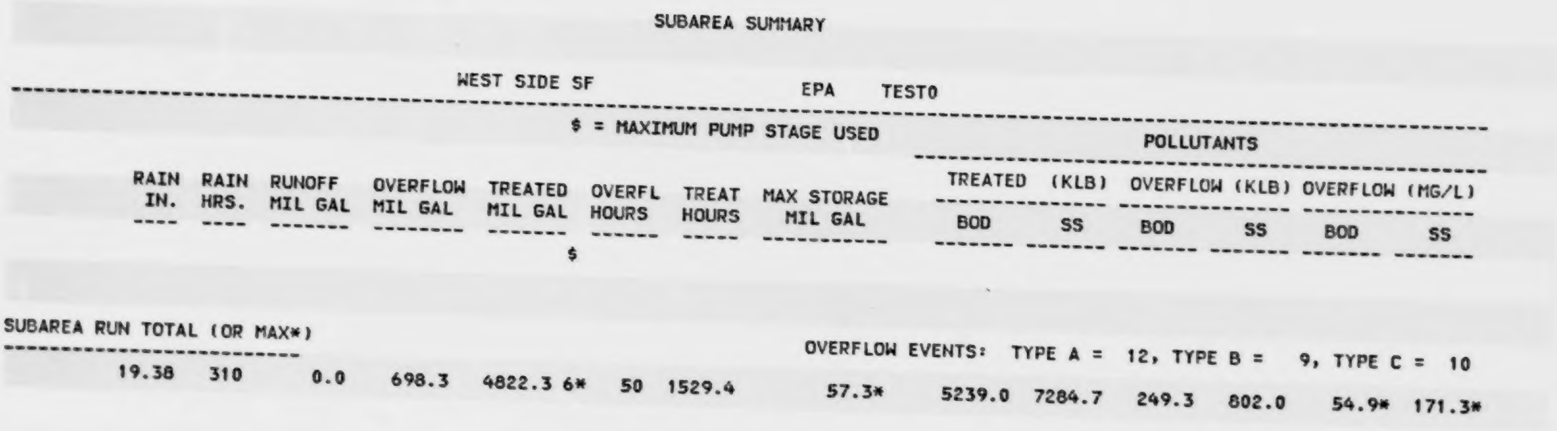
The second part of the printout presents the information generated by EPAMAC. A large amount of data is tabulated. The column heading topics are: rain quantity and duration; runoff, overflow and treated volume; duration of overflow and treatment; maximum storage volume; and pollutant loads. Also included within the table are the calculated number of overflow events. The above information is presented either once for a subarea or yearly, monthly, daily, hourly. An example of the subarea summary (IPRINT = 0 or 5) is shown in Figure 42. Values marked with an asterisk are maximum values attained. The other values are totals for the run. These totals when divided by the time length in years of the rain record yield annual averages.

The next printing frequency, the yearly option (IPRINT = 1), is shown in Figure 43. A line of data is presented for each year of record processed. Up to 15 years are printed per page. At the end of the run, the total subarea information is also printed. This option generates a moderate amount of input when large rainfall data are processed, and allows for examination of yearly variations from the average conditions.

The next more detailed level of printout is the monthly frequency (IPRINT = 2). An example is shown in Figure 44. Data for each month of a water year are tabulated. Each water year appears on one page and a yearly total is printed at the bottom of the page. Subarea summary data are printed after the last water year. Analysis of monthly data gives the user insight into which months stormwater control is most needed. The volume of output generated under this option is larger than for the yearly case, but is still easily manageable.

The selection of the daily print option (IPRINT = 3) can generate a large amount of data (and paper) when long periods of record are being processed. A demonstration of the format of the daily print option is shown in Figure 45. It is suggested that the user specify this option only when interested in analyzing specific sections of the total rainfall record. Historically high-rainfall periods can be placed in separate rainfall files and processed.

The daily printout consists of 1 month of daily data per page plus a monthly summary line. Yearly summaries occur after the last month in the water year. Subarea summary data occur at the end of the EPAMAC run. Analysis of the daily data will allow insight in utilization of storage, and the occurrence and duration of high treatment and storage requirements. The user is reminded that daily printout is only representative of actual conditions since the simplifying assumptions of the model make the results less precise at this time scale.



```
                                               SUBAREA SUMMARY

                              WEST SIDE SF                 EPA    TESTO
-----------------------------------------------------------------------------------------------------------------
                                        $ = MAXIMUM PUMP STAGE USED                        POLLUTANTS
                                                                        -----------------------------------------
       RAIN RAIN  RUNOFF  OVERFLOW  TREATED  OVERFL  TREAT  MAX STORAGE   TREATED  (KLB) OVERFLOW (KLB) OVERFLOW (MG/L)
        IN. HRS. MIL GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL     -------------- -------------- ---------------
       ---- ----  -------  --------  -------  ------  -----  -----------    BOD      SS     BOD     SS     BOD     SS
                                             $                            ------- ------- ------- ------- ------- -------

SUBAREA RUN TOTAL (OR MAX*)
--------------------------                                        OVERFLOW EVENTS:  TYPE A =  12, TYPE B =   9, TYPE C =  10
        19.38  310    0.0    698.3   4822.3 6*   50  1529.4      57.3*    5239.0  7284.7   249.3   802.0    54.9*  171.3*
```

Figure 42. Main program printout - subarea summary.

```
                                                      YEARLY SUMMARY

                                        WEST SIDE SF                EPA    TEST1
---------------------------------------------------------------------------------------------------------------------------------
                                                 $ = MAXIMUM PUMP STAGE USED                      POLLUTANTS
                                                                            -----------------------------------------------------
                                                                              TREATED  (KLB)  OVERFLOW (KLB) OVERFLOW (MG/L)
  WATER    RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL  TREAT  MAX STORAGE  ---------------  --------------- ---------------
  YEAR      IN.  HRS.  MIL GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL      BOD     SS      BOD     SS      BOD     SS
---------  ----  ----  -------  --------  -------  ------  -----  -----------  ------- ------- ------- ------- ------- -------
                                                  $
  1972    19.38   310      0.0     698.3   4822.3 6*    50  1529.4       57.3*   5239.0  7284.7   249.3   802.0    54.9*  171.3*
                                                                 OVERFLOW EVENTS:  TYPE A =  12, TYPE B =   9, TYPE C =  10


SUBAREA RUN TOTAL (OR MAX*)                                      OVERFLOW EVENTS:  TYPE A =  12, TYPE B =   9, TYPE C =  10
---------------------------
          19.38   310      0.0     698.3   4822.3 6*    50  1529.4       57.3*   5239.0  7284.7   249.3   802.0    54.9*  171.3*
```

Figure 43. Main program printout - yearly summary.

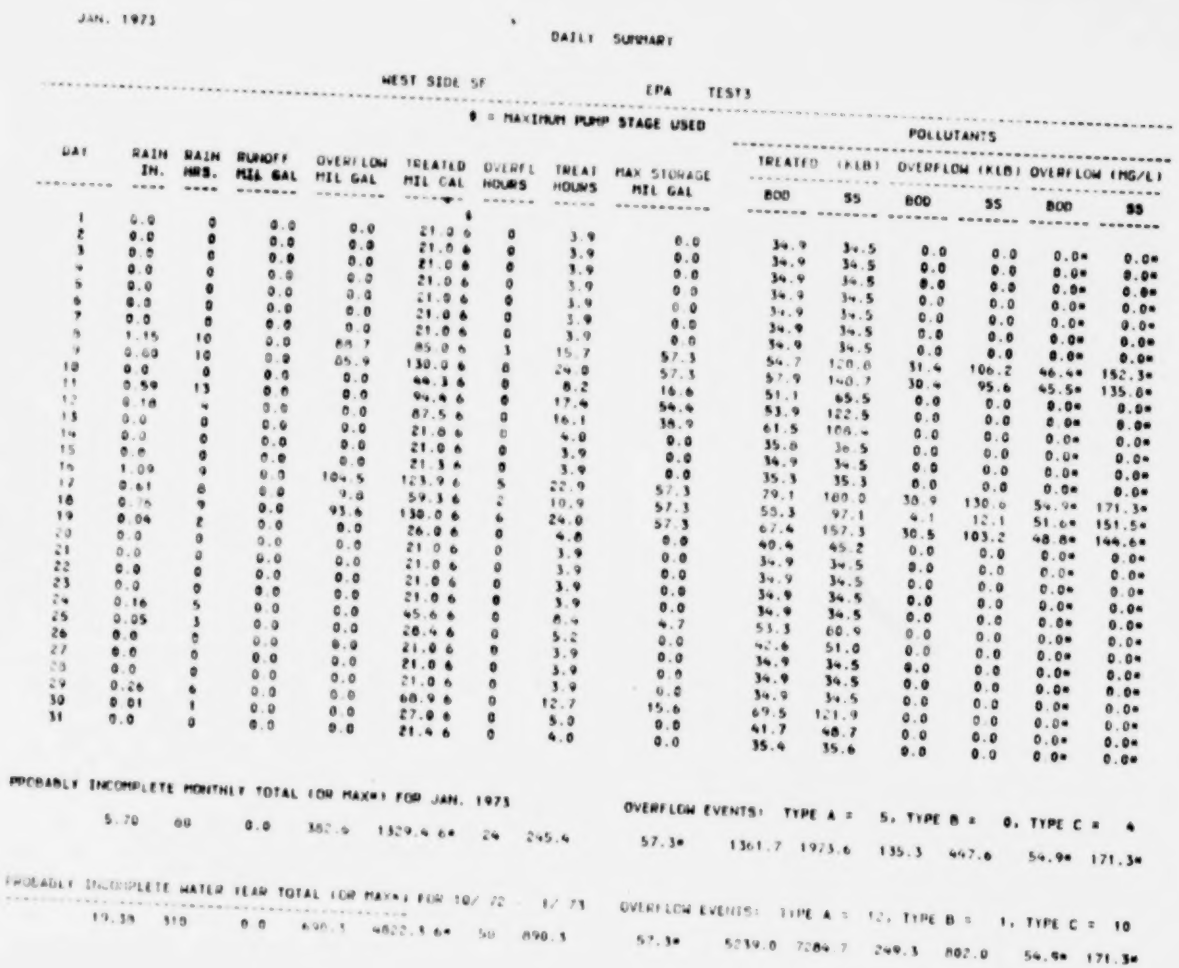
```
     1972
                                             MONTHLY  SUMMARY

                                  WEST SIDE SF                    EPA    TEST2
-------------------------------------------------------------------------------------------------------------------------------
                                        $ = MAXIMUM PUMP STAGE USED
                                                                                                POLLUTANTS
                                                                                -----------------------------------------------
  MONTH     RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL  TREAT  MAX STORAGE   TREATED  (KLB)  OVERFLOW (KLB) OVERFLOW (MG/L)
             IN.  HRS.  MIL GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL     --------------  -------------- ---------------
---------   ----  ----  -------  --------  -------  ------  -----  -----------     BOD      SS      BOD     SS     BOD      SS
                                                                                 ------- ------- ------- ------- ------- -------
  OCT.      5.13    69      0.0     170.3  1056.4 6*    26  438.2
                                                 $
  NOV.      5.52    77      0.0     373.4  1097.8 6*    28  469.4       57.3*     1224.8  1634.5  102.2   235.1   113.5*  207.3*
                                                                       OVERFLOW EVENTS:  TYPE A =  9, TYPE B =  8, TYPE C =  5
  DEC.      3.03    84      0.0      85.5  1025.3 6*    13  460.2       57.3*     1202.6  1637.4  165.9   448.7    95.1*  191.0*
                                                                       OVERFLOW EVENTS:  TYPE A =  7, TYPE B =  6, TYPE C =  5
  JAN.      5.70    80      0.0     533.1  1178.9 6*    34  501.9       57.3*     1259.6  1608.4   36.3   101.4    89.8*  177.5*
                                                                       OVERFLOW EVENTS:  TYPE A =  3, TYPE B =  2, TYPE C =  2
                                                                        57.3*     1271.1  1768.4  225.9   652.8   100.1*  189.6*
                                                                       OVERFLOW EVENTS:  TYPE A =  8, TYPE B =  8, TYPE C =  5


PROBABLY INCOMPLETE WATER YEAR TOTAL (OR MAX*) FOR 10/ 72 -  1/ 73      OVERFLOW EVENTS:  TYPE A = 27, TYPE B = 24, TYPE C = 17
-----------------------------------------------------
           19.38   310      0.0    1162.2  4358.4 6*   101 1869.6       57.3*     4958.1  6648.7  530.3  1438.0   113.5*  207.3*

SUBAREA RUN TOTAL (OR MAX*)
---------------------------                                             OVERFLOW EVENTS:  TYPE A = 27, TYPE B = 24, TYPE C = 17
           19.38   310      0.0    1162.2  4358.4 6*   101 1869.6       57.3*     4958.1  6648.7  530.3  1438.0   113.5*  207.3*
```

Figure 44. Main program printout - monthly summary.



```
JAN. 1973                                   DAILY  SUMMARY

------------------------------------ WEST SIDE SF                 EPA    TEST3 -----------------------------------------------------
                                         $ = MAXIMUM PUMP STAGE USED
                                                                                                 POLLUTANTS
                                                                                ---------------------------------------------------
   DAY     RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL  TREAT  MAX STORAGE   TREATED  (KLB)  OVERFLOW (KLB)  OVERFLOW (MG/L)
            IN.  HRS.  MIL GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL     --------------  --------------  ---------------
---------  ----  ----  -------  --------  -------  ------  -----  -----------    BOD     SS      BOD     SS      BOD      SS
                                                                                 ------- ------- ------- ------- ------- -------
                                             $
     1     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     2     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     3     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     4     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     5     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     6     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     7     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
     8     1.15   10      0.0     88.7    85.0 6     3     15.7       57.3       54.7   120.8    31.4   106.2   46.4*   152.3*
     9     0.60   10      0.0     85.9   130.0 6     8     24.0       57.3       57.9   140.7    30.4    95.6   45.5*   135.8*
    10     0.0     0      0.0      0.0    44.3 6     0      8.2       16.6       51.1    65.5     0.0     0.0    0.0*    0.0*
    11     0.59   13      0.0      0.0    94.4 6     0     17.4       54.4       53.9   122.5     0.0     0.0    0.0*    0.0*
    12     0.18    4      0.0      0.0    87.5 6     0     16.1       38.9       61.5   108.4     0.0     0.0    0.0*    0.0*
    13     0.0     0      0.0      0.0    21.8 6     0      4.0        0.0       35.8    36.5     0.0     0.0    0.0*    0.0*
    14     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    15     0.0     0      0.0      0.0    21.3 6     0      3.9        0.0       35.3    35.3     0.0     0.0    0.0*    0.0*
    16     1.09    9      0.0    104.5   123.9 6     5     22.9       57.3       79.1   180.0    30.9   130.6   54.9*   171.3*
    17     0.61    8      0.0      9.8    59.3 6     2     10.9       57.3       53.3    97.1     4.1    12.1   51.6*   151.5*
    18     0.76    9      0.0     93.6   130.0 6     6     24.0       57.3       67.4   157.3    30.5   103.2   48.8*   144.6*
    19     0.04    2      0.0      0.0    26.0 6     0      4.0        0.0       40.4    45.2     0.0     0.0    0.0*    0.0*
    20     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    21     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    22     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    23     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    24     0.16    5      0.0      0.0    45.6 6     0      8.4        4.7       53.3    60.9     0.0     0.0    0.0*    0.0*
    25     0.05    3      0.0      0.0    28.4 6     0      5.2        0.0       42.6    51.0     0.0     0.0    0.0*    0.0*
    26     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    27     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    28     0.0     0      0.0      0.0    21.0 6     0      3.9        0.0       34.9    34.5     0.0     0.0    0.0*    0.0*
    29     0.26    6      0.0      0.0    68.9 6     0     12.7       15.6       69.5   121.9     0.0     0.0    0.0*    0.0*
    30     0.01    1      0.0      0.0    27.0 6     0      5.0        0.0       41.7    48.7     0.0     0.0    0.0*    0.0*
    31     0.0     0      0.0      0.0    21.4 6     0      4.0        0.0       35.4    35.6     0.0     0.0    0.0*    0.0*

PROBABLY INCOMPLETE MONTHLY TOTAL (OR MAX*) FOR JAN. 1973          OVERFLOW EVENTS:  TYPE A =  5, TYPE B =  0, TYPE C =  4

           5.70   80      0.0    382.6  1329.4 6*   24    245.4      57.3*     1361.7  1973.6   135.3   447.6   54.9*   171.3*

PROBABLY INCOMPLETE WATER YEAR TOTAL (OR MAX*) FOR 10/ 72 -  1/ 73  OVERFLOW EVENTS:  TYPE A = 12, TYPE B =  1, TYPE C = 10
---------------------------------------------------------------
          19.38  310      0.0    690.1  4822.3 6*   50    890.3      57.3*     5239.0  7284.7   249.3   802.0   54.9*   171.3*
```

Figure 45. Main program printout - daily summary.

The last printout option, and the most detailed, is the hourly frequency (IPRINT = 4). The user is warned not to specify this option on large rainfall files without first estimating the volume of printout and associated cost (see Table 20). Use this option only after establishment of the need for this level of detail. An example of the printout form is shown in Figure 46.

The hourly option prints hourly data for 1 day on a page. Only hours with flow (either dry-weather or stormwater) are printed. In a run where dry-weather flow is incorporated, every hour per day will be printed and all days of record will be shown. If dry-weather flow is not included, then the volume of printout may be much smaller; only non-zero flow hours are printed. Non-zero flow hours contain rainfall and runoff, or flow from dewatering storage after a storm. Days with no hourly flow for 24 hours are not printed. Hence, an EPAMAC run, which does not have dry-weather flow and only 100 days of rainfall per year, may generate one-third the output that a run incorporating 365 days of dry-weather flow would generate. EPAMAC runs for regions with essentially all year rainfall would not have reduced output.

Daily, monthly, yearly, and subarea summary total lines appear as appropriate throughout the hourly printout. The hourly option is useful when examining periods of high rainfall to determine estimates of storage dewatering times and storage treatment interrelationships. As with the daily option, results are representative only.

The hourly and daily print options are most commonly used on final alternative runs for selected periods of record. The selection of the periods of interest will usually be apparent from the rainfall analyses conducted in the input preparation phase (see previous discussion). Yearly and monthly runs may be most informative when executed in final alternative runs. Clearly, the specific user needs will control their selection.

The subarea option is probably the most frequently chosen print option for the preliminary combination runs and other cases where detailed examination is not required. This option can be used in fine tuning runs to establish an average overflow frequency. The prime data needed in these runs is the total number of overflow events. The annual average overflow guides the user in adjusting the storage and/or treatment capacities up or down to attain the desired frequency.

End Statistical Summary--

The last page of the EPAMAC output presents the mass balances for the run. BOD, SS, and flow are tabulated by source (runoff, dry-weather flow, or lateral inflow) and by method of disposal (treatment, overflow, or storage). The total load or volume, and percent contribution are calculated for each category. A sample

```
OCT. 1972                                          HOURLY  SUMMARY

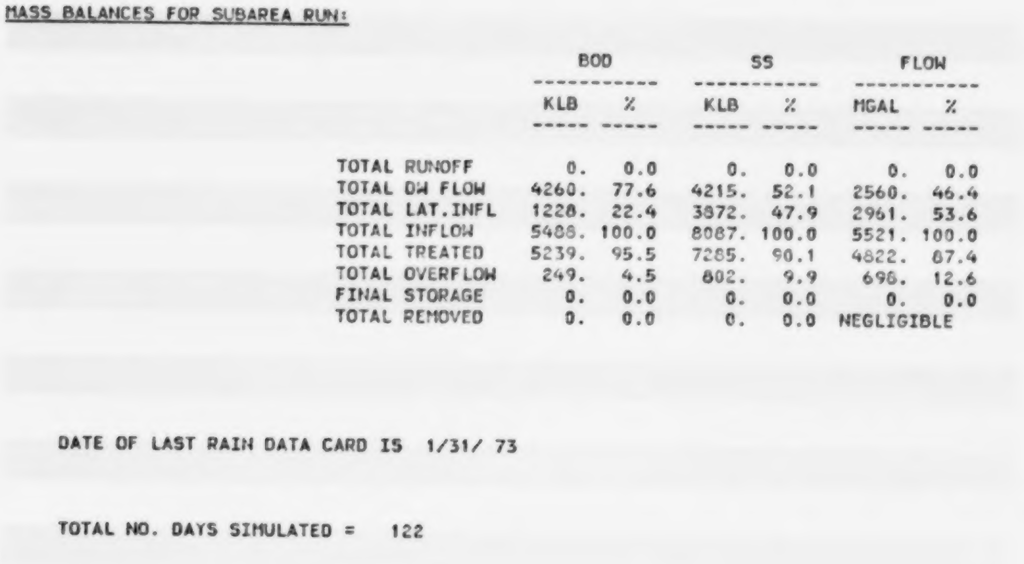
                                         WEST SIDE SF                  EPA    TEST4
----------------------------------------------------------------------------------------------------------------------------
                                                    $ = MAXIMUM PUMP STAGE USED                         POLLUTANTS
                                                                                  ------------------------------------------
DAY  HOUR  RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL  TREAT  MAX STORAGE    TREATED  (KLB)  OVERFLOW (KLB) OVERFLOW (MG/L)
            IN.  HRS.  MIL GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL      ---------------  --------------- ---------------
                                                                                   BOD      SS      BOD      SS      BOD      SS
---- ---- ---- ---- ------- -------- ------- ------ ----- -----------  ------- ------- ------- ------- ------- -------
                                               $
 13    1  0.0     0      0.0      0.0    0.7 1     0      0.3        0.0        0.9     0.7     0.0     0.0     0.0     0.0
 13    2  0.0     0      0.0      0.0    0.5 1     0      0.2        0.0        0.4     0.3     0.0     0.0     0.0     0.0
 13    3  0.0     0      0.0      0.0    0.4 1     0      0.2        0.0        0.3     0.2     0.0     0.0     0.0     0.0
 13    4  0.0     0      0.0      0.0    0.4 1     0      0.2        0.0        0.2     0.1     0.0     0.0     0.0     0.0
 13    5  0.0     0      0.0      0.0    0.3 1     0      0.2        0.0        0.2     0.1     0.0     0.0     0.0     0.0
 13    6  0.0     0      0.0      0.0    0.3 1     0      0.2        0.0        0.2     0.1     0.0     0.0     0.0     0.0
 13    7  0.0     0      0.0      0.0    0.5 1     0      0.2        0.0        0.6     0.3     0.0     0.0     0.0     0.0
 13    8  0.0     0      0.0      0.0    0.9 1     0      0.4        0.0        1.3     1.6     0.0     0.0     0.0     0.0
 13    9  0.0     0      0.0      0.0    1.1 1     0      0.5        0.0        2.3     2.7     0.0     0.0     0.0     0.0
 13   10  0.0     0      0.0      0.0    1.2 1     0      0.6        0.0        2.7     3.3     0.0     0.0     0.0     0.0
 13   11  0.0     0      0.0      0.0    1.3 1     0      0.6        0.0        2.4     3.1     0.0     0.0     0.0     0.0
 13   12  0.0     0      0.0      0.0    1.2 1     0      0.6        0.0        2.2     2.2     0.0     0.0     0.0     0.0
 13   13  0.17    1      0.0      0.0    5.4 6     0      1.0        5.3        6.5    12.4     0.0     0.0     0.0     0.0
 13   14  0.06    1      0.0      0.0    5.4 6     0      1.0       10.8        5.9    11.8     0.0     0.0     0.0     0.0
 13   15  0.0     0      0.0      0.0    5.4 6     0      1.0        8.8        5.6    11.2     0.0     0.0     0.0     0.0
 13   16  0.0     0      0.0      0.0    5.4 6     0      1.0        4.9        5.7    10.7     0.0     0.0     0.0     0.0
 13   17  0.0     0      0.0      0.0    5.4 6     0      1.0        0.4        6.2    10.1     0.0     0.0     0.0     0.0
 13   18  0.0     0      0.0      0.0    1.3 1     0      0.6        0.0        2.1     2.1     0.0     0.0     0.0     0.0
 13   19  0.0     0      0.0      0.0    1.1 1     0      0.5        0.0        1.9     1.7     0.0     0.0     0.0     0.0
 13   20  0.0     0      0.0      0.0    1.1 1     0      0.5        0.0        2.2     2.0     0.0     0.0     0.0     0.0
 13   21  0.0     0      0.0      0.0    1.1 1     0      0.5        0.0        2.1     2.1     0.0     0.0     0.0     0.0
 13   22  0.0     0      0.0      0.0    1.0 1     0      0.5        0.0        2.1     1.9     0.0     0.0     0.0     0.0
 13   23  0.0     0      0.0      0.0    0.9 1     0      0.5        0.0        1.6     1.4     0.0     0.0     0.0     0.0
 13   24  0.0     0      0.0      0.0    0.8 1     0      0.4        0.0        1.2     1.0     0.0     0.0     0.0     0.0

DAILY TOTAL (OR MAX*)

 13       0.23    2      0.0      0.0   43.4 6*    0     12.8       10.8*      56.8    83.2     0.0     0.0     0.0*    0.0*
```

Figure 46. Main program printout - hourly summary.

summary is shown in Figure 47. The last rain date and total number of days simulated are also printed on this page.



```
MASS BALANCES FOR SUBAREA RUN:

                                  BOD            SS             FLOW
                              -----------    -----------    -----------
                               KLB    %       KLB    %      MGAL    %
                              ----- -----    ----- -----    ----- -----

             TOTAL RUNOFF        0.   0.0       0.   0.0       0.   0.0
             TOTAL DW FLOW    4260.  77.6    4215.  52.1    2560.  46.4
             TOTAL LAT.INFL   1228.  22.4    3872.  47.9    2961.  53.6
             TOTAL INFLOW     5488. 100.0    8087. 100.0    5521. 100.0
             TOTAL TREATED    5239.  95.5    7285.  90.1    4822.  87.4
             TOTAL OVERFLOW    249.   4.5     802.   9.9     698.  12.6
             FINAL STORAGE       0.   0.0       0.   0.0       0.   0.0
             TOTAL REMOVED       0.   0.0       0.   0.0   NEGLIGIBLE


    DATE OF LAST RAIN DATA CARD IS  1/31/ 73


    TOTAL NO. DAYS SIMULATED =   122
```

Figure 47. End statistical summary.

Interpretation of Results

The EPAMAC user instruction so far has discussed system schematic development, execution logistics, input data preparation, and example input and output format. The last topic of EPAMAC instruction is how to interpret the output. Successful EPAMAC run output and unsuccessful runs where errors occur are discussed.

Successful Execution Results--

The discussion of successful computer runs examines the output columns sequentially. Examples of information that can be derived from interpretation of each type of output data are presented. The topics addressed are rain, flow volume, pump state and storage volume, overflow events, and pollutant loads.

In base runs, the rainfall shown in the output is the rain used to calculate runoff volumes. However, in combining and final runs where no runoff is calculated, the rain output has a different interpretation. Recall, from earlier discussion, a rain file is required to run the internal clock of EPAMAC. For cases where no runoff is being calculated, any rainfall file covering the period of analysis and having a typical rainfall pattern is adequate to drive the program. The rain data are printed in this case as a reference for the user. Examination of the rain columns indicates the relative rainfall conditions producing the results in other output columns. Periods of high or low rainfall intensity can be identified. The user must remember in this case where runoff is not being calculated; the rain data are not a summation of the rainfall used to produce the overflow or treated volumes being processed on that particular run.

The runoff, overflow, and treatment volumes are important EPAMAC outputs. The user should examine these volumes when dealing with stormwater to understand the magnitude of flows under consideration. The subarea totals and mass balance summary at the end of the printout provide information on the interrelationships of the various flow streams. In the example presented in Figure 47, 46% of the total flow is dry-weather flow, and 87% of the total wastewater flow is treated. In analyzing the contribution from various flow streams, the user must identify, in a given EPAMAC run, whether the tabulated overflow data are really overflows or runoff from a subarea as in a base run. The overflow and treated titles in the output will vary in their exact interpretation depending on whether the run is a base run or a final combining run.

The next column in the output (column headed by $ in Figure 46) is the maximum pump stage or used pump capacity. If the highest pump stage attained is less than the maximum, then the user interprets that no overflows occurred and the configuration in that run contains either an unnecessarily large pumping capacity or storage volume. The output column listing maximum storage volume attained can be used in a similar manner. An EPAMAC run with a specific pumping capacity and essentially infinite storage capacity (STMAX = 99999.99) can be run to determine the upper limit of storage requirements preventing overflows for that pumping capacity. By considering these two output columns, the user has a guide in selecting values for subsequent EPAMAC runs.

Additional information determined from pumping and storage output data is dewatering times for storage facilities. Hourly printout for a period during maximum rainfall is indicative of maximum dewatering conditions. The dewatering time is the number of hours elapsed from the last hour of rainfall until pumping reaches either dry-weather or zero level indicating storage is empty. An example of a 3 hour dewatering time can be seen in Figure 46 on October 13, 1972 from 15:00 to 18:00 hours. It is possible for storage to be full at the end of an EPAMAC run. The program will terminate the day after the last rainfall data, perhaps not allowing sufficient time for complete dewatering of facilities.

In addition to storage and pump stage, the frequency and duration of overflow events must also be interpreted. Observation of overflow data illustrates the cycling effects on facilities which handle the wastewater. Overflow data are also a basis for estimating receiving water impacts. More detailed analysis of overflow data can be achieved through use of the postprocessor programs. Interpretation of that data is presented in the postprocessor user instruction section.

Pollutant loads are the last category of EPAMAC output for interpretation. As with flows, the contribution of pollutants from the various flow streams is tabulated in the mass balance summary table. The user can thus identify the major sources of pollutants. The third column in the main output presents maximum concentrations in the wastewater, illustrating the magnitude involved. This column is especially useful when treated flow is specified as a percent removal. In conditions of extremely high pollutant concentration, the effluent concentration, when determined by percent removal, may be above acceptable levels; this condition would be indicated by the third pollutant column. If average pollutant concentrations are desired, the user can calculate them from total flow and loads.

Other types of information that can be interpreted from successful run results may become apparent as the user gains familiarity with EPAMAC.

EPAMAC Run Error Indications--

The discussion of unsuccessful computer runs is divided into three categories. The first is when no output is generated; the second is when partial output is generated; and the third is when output is complete but other indications of error are present. Interpretation of results for the three cases should lead the user in identifying the problem(s). A systematic approach to investigating the clues from an unsuccessful run will hasten solution. The following discussion is a guide to aid the user in establishing an error detection methodology. Typical causes of error and symptoms are presented.

The first case of run failure is if no output is generated. The first printout from the EPAMAC model is a line including the statement SIMULATION STARTED. If this line does not exist in the printout or if no printout exists, the error most likely relates to computer job control statements used to initiate the run. The user should doublecheck the syntax used in submitting the input file. If job control statements exist (as in an IBM system), the user should also check to see if a duplicate file name was chosen, if file specifications are proper, and if any empty files were created. Another item to check is the first line of input data, because it is read before the program prints out SIMULATION STARTED. The user should also observe if any system error messages were generated. These error messages can be a great help in locating the problem.

If in the procedure presented above, syntax or input errors were discovered, correct them and resubmit the run. If nothing is obviously wrong or the error occurs during opening files, the user should seek guidance from the system operator or consultant. The program may not have been set up properly on the system. Be sure to delete files that were erroneously created to avoid unnecessary clutter and confusion.

The second case of errors results in partial generation of output as the run terminates before completion. The user can identify a completed run by the last EPAMAC output line which contains the words SIMULATION ENDED. This phrase will not be printed in an incomplete run. The user should again look for system error messages. EPAMAC diagnostics may also have generated error or warning statement(s). Other items to check are the repeated input data for errors and the program start date.

Error messages will usually indicate where the problem occurred. Typical problems in this second case involve shifted input data, where the program attempts to read a letter as a number and fails. Reexamination of input data will confirm if the data are correct. The user should verify that the printed start date is not chronologically after the first rainfall input data date. If the start date is out of sequence, the program searches for a date match indefinitely until a maximum time limit for the job is exceeded.

Another clue to the user in identifying errors is where the program terminated. The user can refer to flow charts or the computer code to isolate area of termination. For example, if the program ended after one subarea with a message stating END OF DATA ON UNIT x or stating DATA ARE NOT IN EXPECTED FORMAT, then the difficulty may be that no 9s exist to signal the end of the rain data. The first message occurs because the end of file was reached but no 9s signaled the program to stop. In the second message, the program likely read the first input card of the next subarea expecting rain data but getting characters instead. The solution here is also due to missing 9s at the end of the rain data.

In another example, if the printout terminates where a file is to be written or read, the problem may relate to improper updating of the file pointer. This error can occur where a run uses one rain file for all subareas and the file pointer update (rewind) was not included when EPAMAC was installed on the system. Commonly, input errors are the typical cause of errors. It is prudent to doublecheck input data before submitting a run.

An EPAMAC run can also have errors even when both SIMULATION STARTED and SIMULATION ENDED identifiers appear. Errors in this third case are usually due to input data error. Doublechecking input data before executing the run will eliminate many runs that fit this error category. All runs should be checked for any error or warning messages, and to be sure input and output numbers are reasonable.

HISTO

The following discussion leads the user through the HISTO application procedure. Sufficient explanation is provided at each stage to permit selection of input variables. Detailed presentation of technical concepts or program documentation are contained in subsequent sections.

Program Processing Steps

The application of HISTO is a multiple step process. The major steps involved are: (1) preparation of the input data file, (2) execution of the computer run, and (3) interpretation of the results.

The user must review the printed output from EPAMAC prior to preparing the input data file for HISTO. This allows the determination of the ranges of values to be used as input values for the summary tables and histogram plots to be generated. The user must select which of the tables and/or plots will be required for the interpretation of results step.

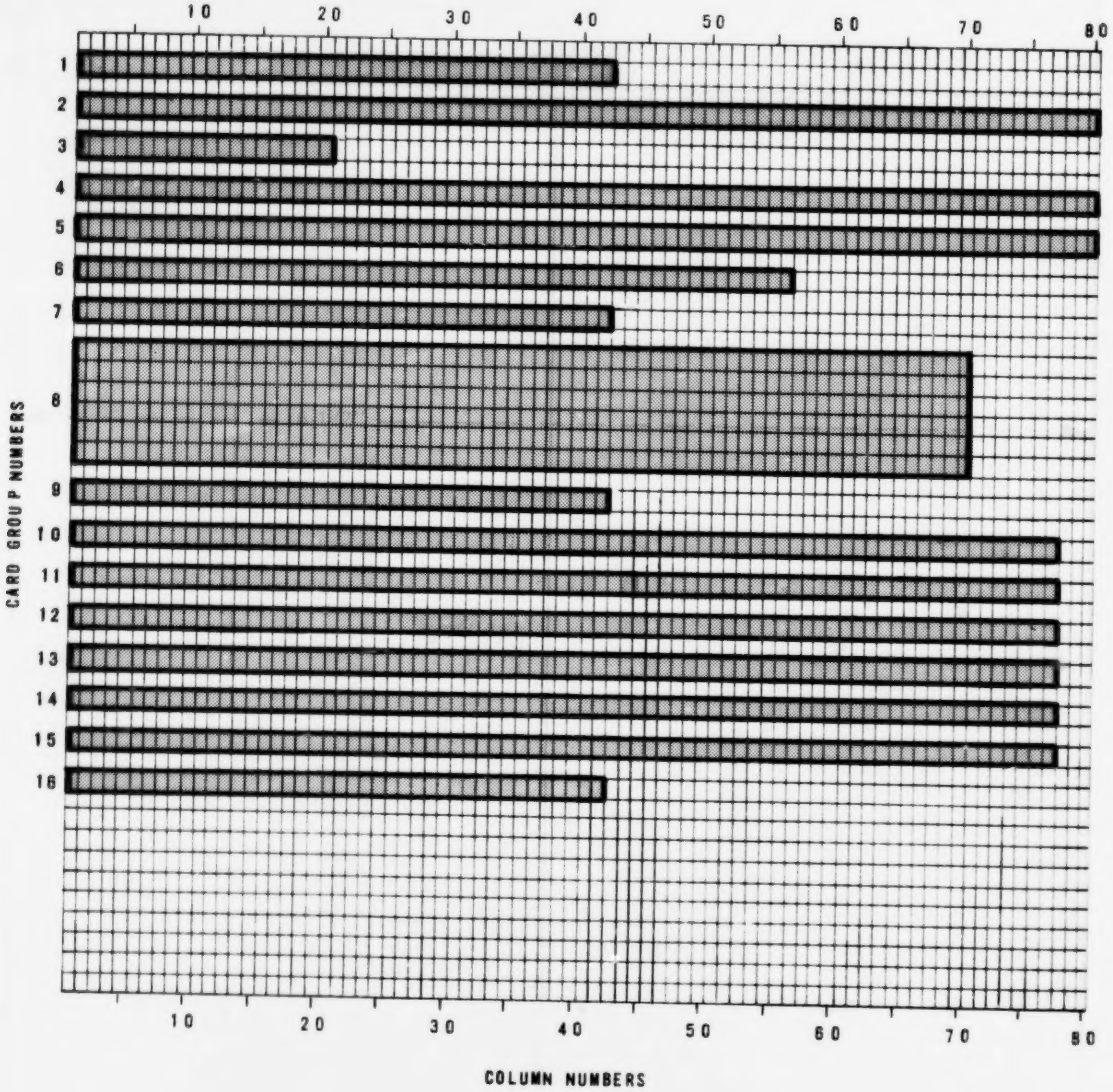
Execution Logistics

Execution file handling for HISTO is much simpler than for EPAMAC since only one input file is used for each run. However, that input file can be any output file from a previous EPAMAC run. Most often the input file will be either an actual overflow, treated, or wet-weather flow file.

The use of HISTO does not create or modify any files; it simply uses the input file to generate the desired output. The input file is identified by using the same name as used previously when the EPAMAC file was generated. The logistics of handling the input file involve only identification of the file.

Instructions for Input Data Preparation

The input file is tailored to each run although certain portions can be duplicated for other runs. Modifying a master input data file eliminates the need to completely retype a new file for each run. A blank example of the format of all input cards is shown in Figure 48. The typical data deck setup for HISTO is shown in Figure 49. The input data variables and formats are described later in this section.



BLANK LINES HAVE BEEN INCLUDED BETWEEN INPUT DATA GROUPS FOR CLARITY OF FIGURE. ACTUAL INPUT DATA SHOULD NOT HAVE BLANK LINES

Figure 48. HISTO input data cards format.

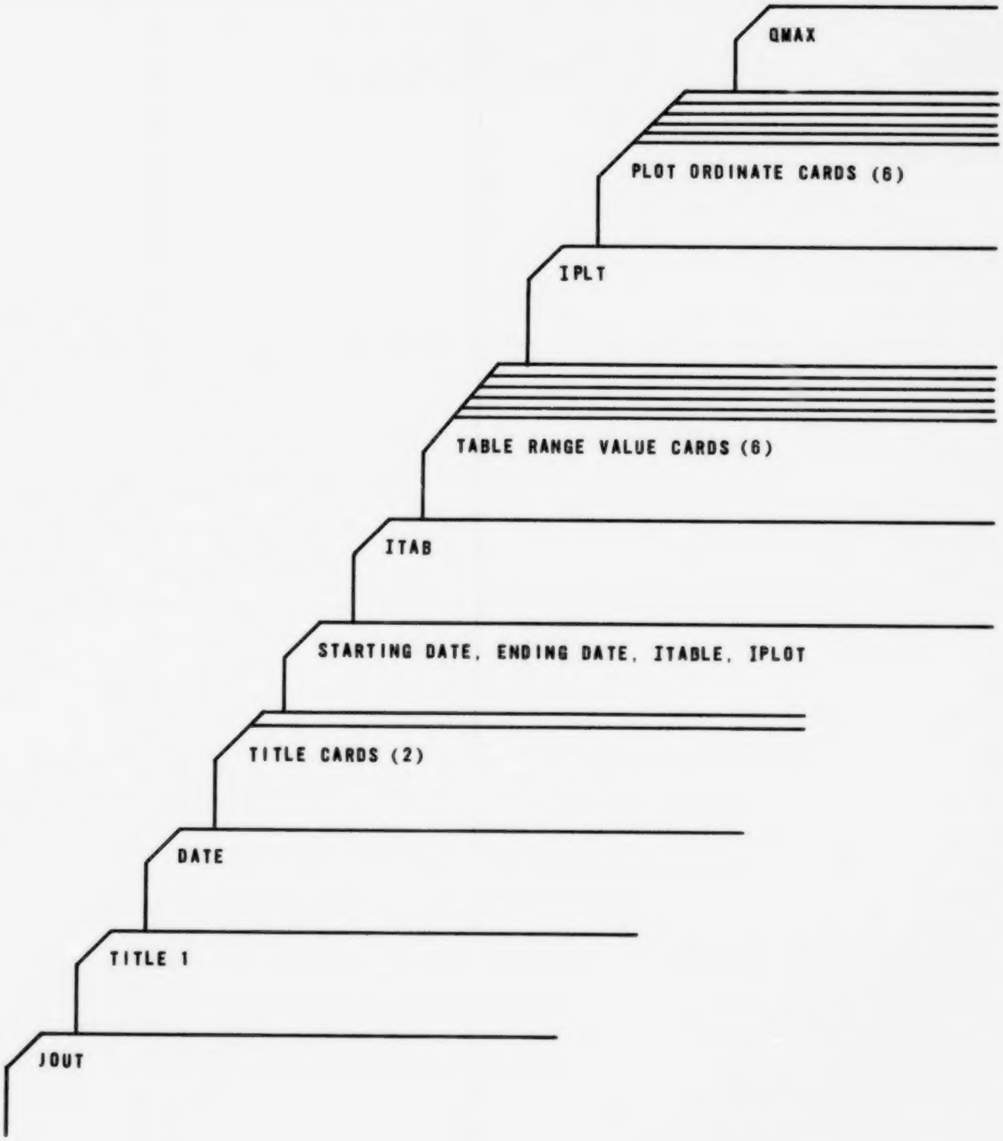

QMAX
PLOT ORDINATE CARDS (6)
IPLT
TABLE RANGE VALUE CARDS (6)
ITAB
STARTING DATE, ENDING DATE, ITABLE, IPLOT
TITLE CARDS (2)
DATE
TITLE 1
JOUT

Figure 49. Data deck for HISTO.

The six categories of input data are: (1) output file identification; (2) user supplied titles; (3) selected time period, plots, and tables; (4) individual table and plot selection; (5) table range values; (6) plot ordinate values; and (7) maximum values for plots. The requirements for each of these categories will be discussed. Variable names will be capitalized.

Output File Identification--

The output file logical unit designations for the various plots are required to keep each of the types of plots (i.e., flowrate, BOD load) grouped together. If the same file unit designation is used for all of the various types of plots, the plots will be grouped by date rather than type. The output file unit number, JOUT, is used in conjunction with the job control language to designate the order in which the plots will be printed.

Titles--

The titles (TITLE1, DATE, TITLE2, and TITLE3) are included to simplify identification of the output. The information in these titles can be anything the user desires. It is recommended that DATE be the date the run is made.

Selected Time Period, Plots, and Tables--

If output information for a specific time period of the record is desired, the beginning and ending dates (inclusive) must be supplied. If these dates are left blank, the printout will cover the entire time period included in the EPAMAC file.

The variables ITABLE (see Figure 50) and IPLOT (see Figure 51) are flags to indicate whether or not any tables or plots are to be included in the printout. At least one table or plot is required or the printout will only echo the input data set.

Individual Table and Plot Selection--

The arrays ITAB in Card Group 7 and IPLT in Card Group 9 identify the individual table(s) and plot(s), respectively, to be included in the printout. Any combination of tables and/or plots may be specified. If plots are requested, then there should be a corresponding JOUT (Card Group 1) specified for each plot.

Table Range Values--

If any tables are to be included in the printout, then table range cards (Card Group 8) for all six tables must be included as shown in Figure 50. The range array, F, may be left blank on cards for any table that is not desired. Thus, up to five table range cards may be blank but they must be included and they must

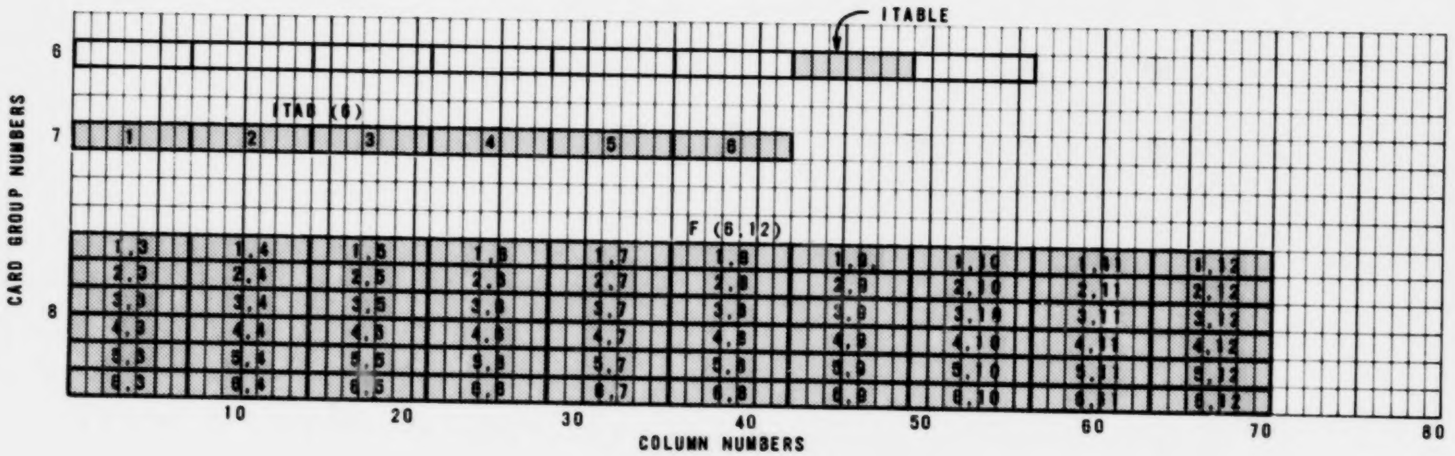


Figure 50. HISTO table variable format.

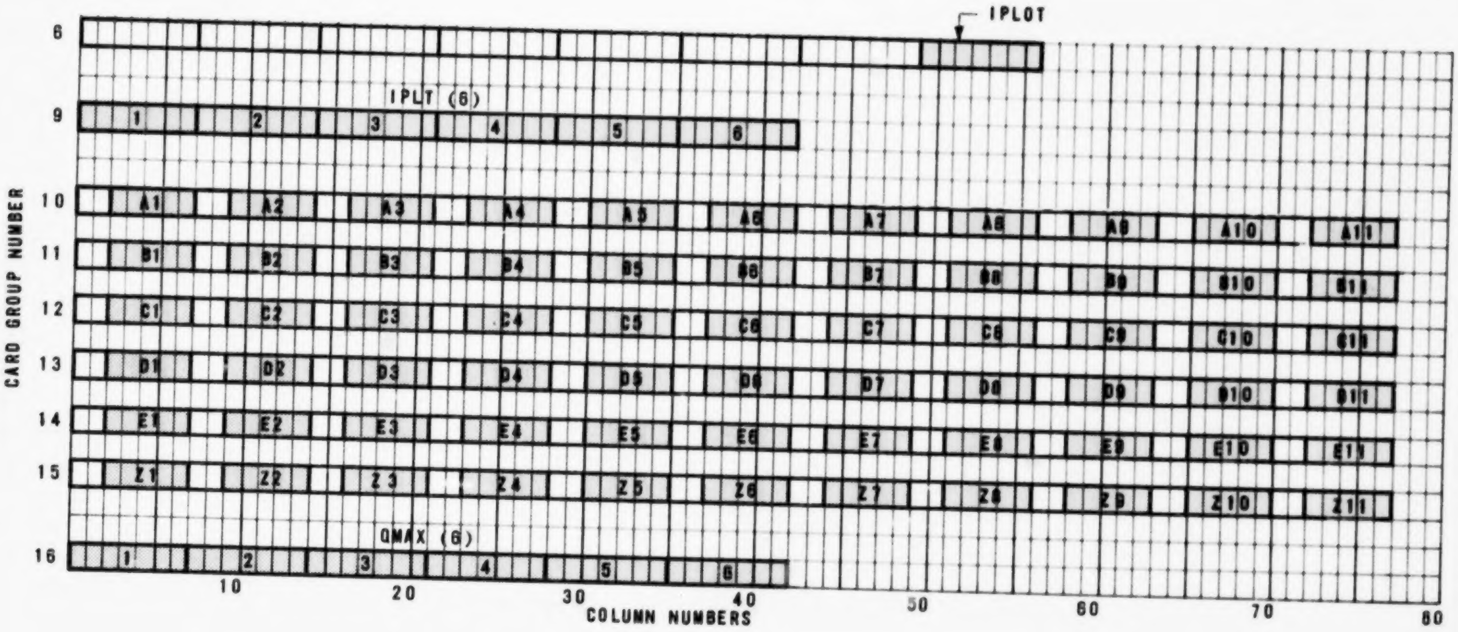


Figure 51. HISTO plot variable formats.

be in order. Ten values must be specified in ascending order on each table range card. The lowest value specified must be greater than 1% of QMAX (Card Group 16) for that particular table.

Plot Ordinate Values--

The plot ordinate values are treated similarly to the table range values. If any plots are to be included in the printout, then all six plot ordinate value cards must be included in the input data file as shown in Figure 51. Again, up to five of these cards may be blank but must be in order. Eleven (11) plot ordinate values must be included on each card. They must begin with zero (0) and end with the same value as QMAX (Card Group 16) for that plot as shown in Figure 51. They must also be in ten equal increments. These values will be printed as the ordinate values on each of the plots requested.

Maximum Values for Plots--

QMAX is the maximum ordinate value for the plots. It must be specified for each plot to be included in the printout.

Example Input

The input variables for HISTO have been outlined above. Data card preparation and sequencing instructions for the complete HISTO program are given in Table 31 with the card groups highlighted.

A listing of actual data presented to the program for execution is shown in Figure 52. A verbal description of the implication of the data follows.

Job Control--

The following I/O specifications apply:

- The input file, WYL.XX.E43.J6643.BCAL.QUALRS1A, used to drive the program is on unit 8.
- The printout for the 5 plots (BOD load, SS load, BOD concentration, SS concentration, and overflow volume) are on units 9, 10, 11, 12, and 13, respectively.

Execution Data--

The following execution input data apply:

- Six plot output files are identified.

Table 31. HISTO CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1	6I7		Output file number for plot		
		1-7	Flowrate	JOUT(1)	None
		8-14	BOD load	JOUT(2)	None
		15-21	SS load	JOUT(3)	None
		22-28	BOD concentration	JOUT(4)	None
		29-35	SS concentration	JOUT(5)	None
		36-42	Hourly overflow volume	JOUT(6)	None
2	20A4	1-80	Title card containing a one-line project description heading to be printed in the output	TITLE1	None
3	5A4	1-20	Title card containing a 20-character calendar date for the run to be printed in the output	DATE	None
4	20A4	1-80	Title card containing a one-line heading to be printed in the output	TITLE2	None
5	20A4	1-80	Title card containing a one-line heading to be printed in the output	TITLE3	None
6	11I7	1-7	Day for start of desired printout	DSTART	None
		8-14	Month for start of desired printout	MOSTAR	None
		15-21	Year for start of desired printout (Last two digits)	ISTART	None
		22-28	Day for end of desired printout	DSTOP	None
		29-35	Month for end of desired printout	MOSTOP	None
		36-42	Year for end of desired printout (Last two digits)	ISTOP	None
		43-49	Flag for printing tables = 0, skip print = 1, plot tables	ITABLE	0
		50-56	Flag for plotting histograms = 0, skip plot = 1, plot histograms	IPLOT	0

NOTE: All nondecimal (I format) numbers must be right-justified.

Table 31 (Continued)

Card group	Format	Card columns	Description	Variable name	Default value
			INCLUDE CARDS 7 AND 8 ONLY IF ITABLE ON CARD 6 HAS THE VALUE 1		
7	6I7		Flag for printing tables = 0, skip table = 1, print table		
		1-7	Flowrate, Mgal/d	ITAB(1)	0
		8-14	BOD load, lb/h	ITAB(2)	0
		15-21	SS load, lb/h	ITAB(3)	0
		22-28	BOD concentration, mg/L	ITAB(4)	0
		29-35	SS concentration, mg/L	ITAB(5)	0
		36-42	Overflow volume, Mgal/h	ITAB(6)	0
			INCLUDE CARD 8 ONLY IF ITABLE ON CARD 6 HAS THE VALUE 1 REPEAT CARD GROUP 8 FOR EACH OF THE 6 TABLES.		
8	10F7.0		Range of values for summary table. Note: F(3) must be greater than 1% of QMAX from Card Group 16.		
		1-7	First range value	F(I,3)	0
		8-14	Second range value	F(I,4)	0
		. . .		. . .	
		64-70	Tenth range value	F(I,12)	0
			INCLUDE CARDS 9 TO 15 ONLY IF IPLOT ON CARD 6 HAS THE VALUE 1		
9	6I7		Flag for plotting histograms = 0, skip plot = 1, plot histogram		
		1-7	Flowrate, Mgal/d	IPLT(1)	0
		8-14	BOD load, lb/h	IPLT(2)	0
		15-21	SS load, lb/h	IPLT(3)	0
		22-28	BOD concentration, mg/L	IPLT(4)	0
		29-35	SS concentration, mg/L	IPLT(5)	0
		36-42	Overflow volume, Mgal/h	IPLT(6)	0

Table 31 (Continued)

Card group	Format	Card columns	Description	Variable name	Default value
10	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for flowrate	A1	None
		10-14	Second plot ordinate value for flowrate	A2	None
		.		.	
		.		.	
		.		.	
		73-77	Eleventh plot ordinate value for flowrate	A11	None
11	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for BOD load	B1	None
		10-14	Second plot ordinate value for BOD load	B2	None
		.		.	
		.		.	
		.		.	
		73-77	Eleventh plot ordinate value for BOD load	B11	None
12	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for SS load	C1	None
		10-14	Second plot ordinate value for SS load	C2	None
		.		.	
		.		.	
		.		.	
		73-77	Eleventh plot ordinate value for SS load	C11	None
13	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for BOD concentration	D1	None
		10-14	Second plot ordinate value for BOD concentration	D2	None
		.		.	
		.		.	
		.		.	
		73-77	Eleventh plot ordinate value for BOD concentration	D11	None

Table 31 (Concluded)

Card group	Format	Card columns	Description	Variable name	Default value
14	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for SS concentration	E1	None
		10-14	Second plot ordinate value for SS concentration	E2	None
		. . .		. . .	
		73-77	Eleventh plot ordinate value for SS concentration	E11	None
15	11(2X,5A1)	3-7	First plot ordinate value (should be zero) for overflow volume	Z1	None
		10-14	Second plot ordinate value for overflow volume	Z2	None
		. . .		. . .	
		73-77	Eleventh plot ordinate value for overflow volume	Z11	None
16	6F7.0		Maximum value for plot. Note: This card must be included even if IPLOT on Card 6 has the value of 0.		
		1-7	Flowrate	QMAX(1)	0
		8-14	BOD load	QMAX(2)	0
		15-21	SS load	QMAX(3)	0
		22-28	BOD concentration	QMAX(4)	0
		29-35	SS concentration	QMAX(5)	0
		36-42	Overflow volume	QMAX(6)	0

```
                                 DATA                                                     CARD GROUP
                                                                                            NUMBER
/*                                                                                        JOB CONTROL
//GO.FT08F001 DD DSN=WYL.XX.E43.J6643.BCAL.QUALRS1A,                                      JOB CONTROL
//              UNIT=DISK,DISP=(OLD),VOL=SER=PUB003                                       JOB CONTROL
//GO.FT09F001 DD SYSOUT=$,DCB=(RECFM=FA,BLKSIZE=133)                                      JOB CONTROL
//GO.FT10F001 DD SYSOUT=$,DCB=(RECFM=FA,BLKSIZE=133)                                      JOB CONTROL
//GO.FT11F001 DD SYSOUT=$,DCB=(RECFM=FA,BLKSIZE=133)                                      JOB CONTROL
//GO.FT12F001 DD SYSOUT=$,DCB=(RECFM=FA,BLKSIZE=133)                                      JOB CONTROL
//GO.FT13F001 DD SYSOUT=$,DCB=(RECFM=FA,BLKSIZE=133)                                      JOB CONTROL
//GO.SYSIN DD *                                                                           JOB CONTROL
     6      9     10     11     12     13                                                      1
    J-6643.3 SAN FRANCISCO MAC DOCUMENTATION - HISTOPLOT EXAMPLE                               2
DECEMBER 30, 1980                                                                              3
    TEST DATA FOR QUALITY AND QUANTITY                                                         4
    RICHMOND-SUNSET 1    AREAS 1, 2, 3, 4        SYNTHETIC MAY 1977                            4
     1      5     77     22      5     77      1      1                                        5
     1      1      1      1      1      1                                                      6
    10     20     30     40     50     60     70     80     90    100                          7
  1000   2000   3000   4000   5000   6000   7000   8000   9000  10000                          8
  1000   2000   3000   4000   5000   6000   7000   8000   9000  10000                          8
    20     40     60     80    100    120    140    160    180    200                          8
    50    100    150    200    250    300    350    400    450    500                          8
   0.5    1.0    1.5    2.0    2.5    3.0    3.5    4.0    4.5    5.0                          8
     1      1      1      1      1      1                                                      8
     0     10     20     30     40     50     60     70     80     90    100                   9
     0   1000   2000   3000   4000   5000   6000   7000   8000   9000  10000                  10
     0   1000   2000   3000   4000   5000   6000   7000   8000   9000  10000                  11
     0     20     40     60     80    100    120    140    160    180  10000                  12
     0     50    100    150    200    250    300    350    400    450    200                  13
   0.0    0.5    1.0    1.5    2.0    2.5    3.0    3.5    4.0    4.5    500                  14
   100  10000  10000    200    500    5.0                                      5.0            15
                                                                                              16
/*                                                                                        JOB CONTROL
```

Figure 52. HISTO example input data.

- The project for which the run is to be made and the date of the run are identified.
- Title information for summary tables is supplied.
- The printout will cover the period from May 1 to May 22, 1977. Both summary tables and histogram plots are to be in the output.
- All six of the summary tables are to be printed.
- Table range values for the six tables are supplied.
- All six of the histogram plots are to be printed.
- Plot ordinate values for the six plots are provided.
- The maximum values to be used in the six plots are listed.

Output Description

Many options are available to the user for output retrieval from HISTO. In the examples presented here, only selected illustrative ones are shown in Figure 53 and Figure 54.

The flowrate summary for the printout period of May 1977 is shown in Figure 53. The flowrate ranges are shown along with the corresponding number of hours on both an incremental and cumulative total basis. The peak flowrate, the total number of days included in the simulation, and the dates of the flow period are also presented.

The histogram plot for the wet-weather flow for two consecutive days is shown in Figure 54. The date and time of day are shown along with the flowrate histogram. The actual flowrate is shown along the margin of the plot. Flowrate values that exceed the maximum value for the plot are indicated by a double plus (++) in the margin. Each plot will contain two consecutive days even if there is no flow on the second day. This avoids the confusion of having two days separated by one or more days with no flow appearing on the same plot. The plots for the other five parameters are similar in nature.

Interpretation of Results

From Figure 53, the amount of time that the flow from the tributary area entered into the storage-transport facility can be determined. For example, for 41 of the 74 hours or 55% of the time, when wet-weather flow occurred, the flowrate was less than 40 Mgal/d (1.8 m^3/s). For 13 hours, the flow was greater than 100 Mgal (378,500 m^3). Wet-weather flow occurred only 14% of the

```
TITLE        :        TEST DATA FOR QUALITY AND QUANTITY
                      RICHMOND-SUNSET 1    AREAS 1, 2, 3, 4       SYNTHETIC MAY 1977


                                      FLOW RATE SUMMARY

------------------------------------------------------------------------------------------------------------

                                                                                 INCREMENT     CUMULATIVE
                                                                                  TOTAL,         TOTAL,
                                                                                  HOURS          HOURS
                                                                                 ---------     ----------

   FLOW RATE GREATER THAN   100. MGAL/D
                                                                                     13             13
   FLOW RATE GREATER THAN    90. MGAL/D  BUT LESS THAN OR EQUAL TO   100. MGAL/D      1             14
   FLOW RATE GREATER THAN    80. MGAL/D  BUT LESS THAN OR EQUAL TO    90. MGAL/D      3             17
   FLOW RATE GREATER THAN    70. MGAL/D  BUT LESS THAN OR EQUAL TO    80. MGAL/D      4             21
   FLOW RATE GREATER THAN    60. MGAL/D  BUT LESS THAN OR EQUAL TO    70. MGAL/D      0             21
   FLOW RATE GREATER THAN    50. MGAL/D  BUT LESS THAN OR EQUAL TO    60. MGAL/D      5             26
   FLOW RATE GREATER THAN    40. MGAL/D  BUT LESS THAN OR EQUAL TO    50. MGAL/D      2             28
   FLOW RATE GREATER THAN    30. MGAL/D  BUT LESS THAN OR EQUAL TO    40. MGAL/D      5             33
   FLOW RATE GREATER THAN    20. MGAL/D  BUT LESS THAN OR EQUAL TO    30. MGAL/D     11             44
   FLOW RATE GREATER THAN    10. MGAL/D  BUT LESS THAN OR EQUAL TO    20. MGAL/D      8             52
   FLOW RATE GREATER THAN     1. MGAL/D  BUT LESS THAN OR EQUAL TO    10. MGAL/D     22             74
   FLOW RATE GREATER THAN     0. MGAL/D  BUT LESS THAN OR EQUAL TO     1. MGAL/D      0             74
   FLOW RATE EQUAL TO ZERO (0.0) MGAL/D
                                                                                    454            528
   TOTAL HOURS                                                                   ---------
------------------------------------------------------------------------------------528---------------------

   PEAK FLOW RATE =    483.0 MGAL/D         TOTAL DAYS =    22         FLOW PERIOD :  1 MAY 1977 TO 22 MAY 1977
```

Figure 53. HISTO summary table example.

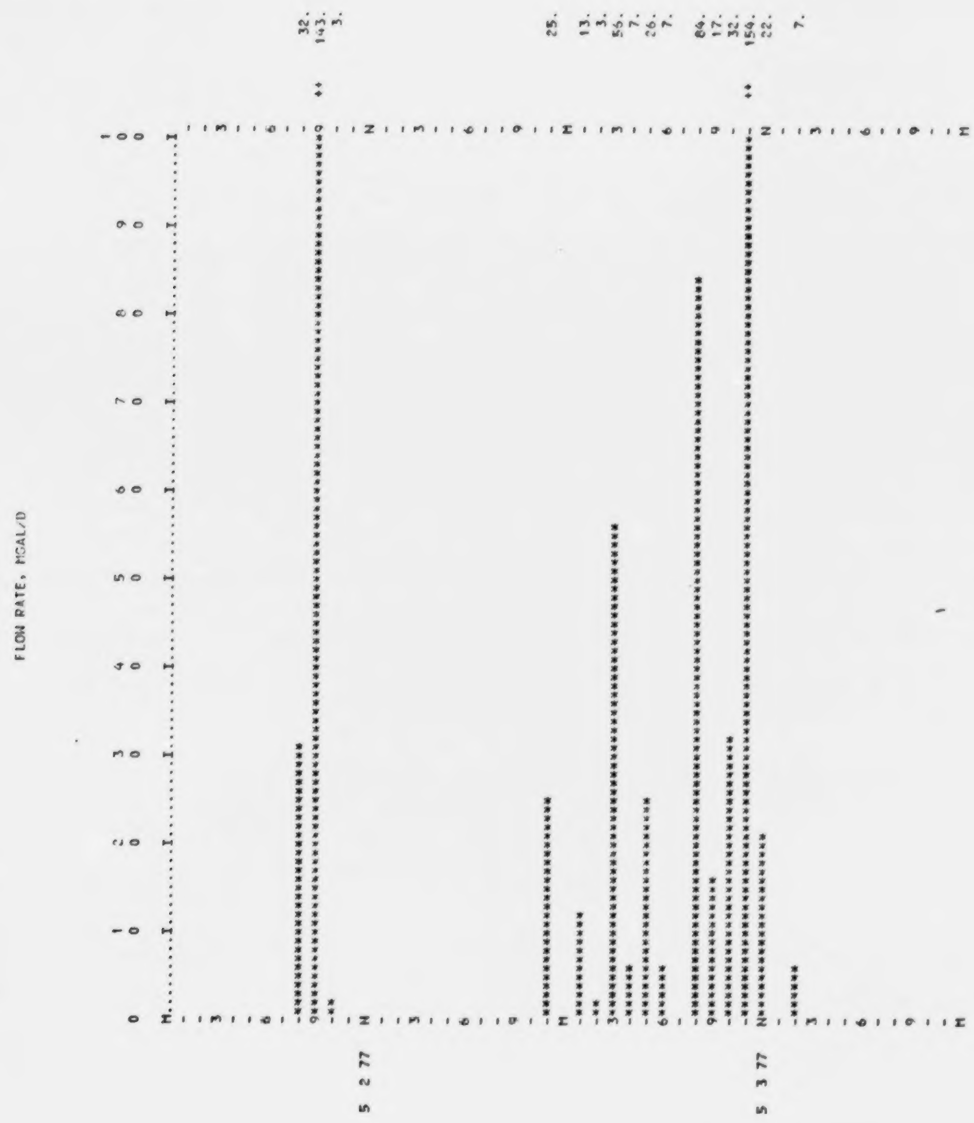


Figure 54. Histogram plot example.

time (74 out of 528 hours) during the 22 days. Also, while most of the time the flowrate was low, the peak flowrate reached was 483 Mgal/d (21.2 m^3/s).

From Figure 54, wet-weather flow occurred for a total of 16 hours during the 2 day period. The longest period with flow was 6 hours (1 to 6 a.m. on May 3) and two periods had flow during only a single hour. The peak flow of 154 Mgal/d (6.8 m^3/s) occurred at 11 a.m. on May 3. Two of the hourly values exceeded the range of the plot, 143 and 154 Mgal/d (6.3 and 6.8 m^3/s) at 9 a.m. on May 2 and 11 a.m. on May 3, respectively.

The histogram plot of the flow is useful in determining how rapidly a wet-weather plant might have to be brought online or how many units within the plant might be required to treat the flow as it arrives. The plots can also be used to compare the effects of times and flowrates reaching the plant for various storage volumes, pumping rates, and plant capacities. The time periods between storms available for plant cleanup can also be determined and compared.

VDAY

The following discussion leads the user through the VDAY program application procedure. Sufficient explanation is provided at each stage to permit selection of input variables. Detailed presentation of technical concepts or program documentation are contained in subsequent sections.

Program Processing Steps

The application of VDAY is a multiple step process similar to that for HISTO. The major steps involved are: (1) selection of the EPAMAC output file to be processed, (2) preparation of the input data file, (3) execution of the computer run, and (4) interpretation of the results.

Review of the EPAMAC output file is necessary to determine that the total time period covered by the file is greater than 20 years (recommended minimum length for evaluating average allowable overflow frequency) and that the time period of interest is included.

The user must also select the proper values for the input data set. Of primary concern are the variables to be used in determining the coliform concentration in the receiving water and the die-away coefficient. It might be necessary for the user to perform regression analyses on local data or field studies to determine the appropriate values for input to VDAY.

Execution of the program and interpretation of the results are similar to that for HISTO.

Execution Logistics

Execution file handling for VDAY is similar to that for HISTO. The user is referred to that section for more detailed discussion. Most often, VDAY is applied to an EPAMAC overflow output file but it can be applied to any EPAMAC output file if desired.

Instructions for Input Data Preparation

The input file is tailored to each run although certain portions can be duplicated for other runs. Preparing a master input data file that can be modified for successive runs is the most expedient method. The typical data deck setup for VDAY is shown in Figure 55. A blank example of the format of all input cards is shown in Figure 56.

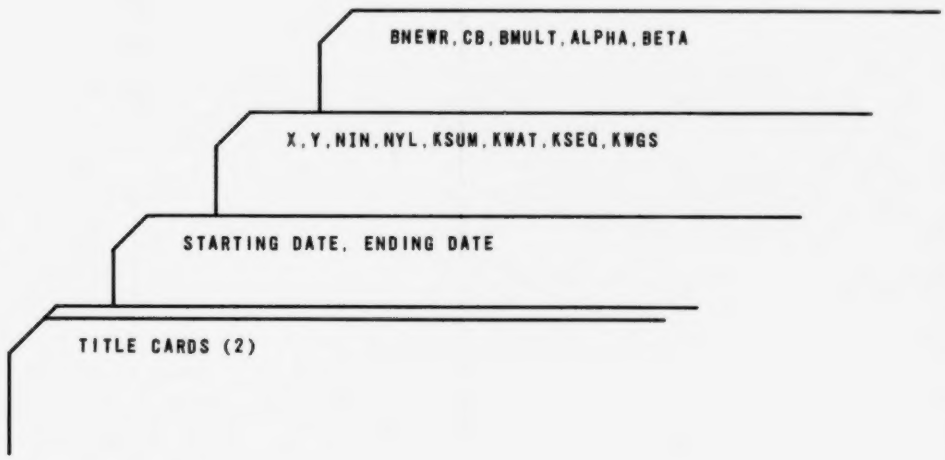
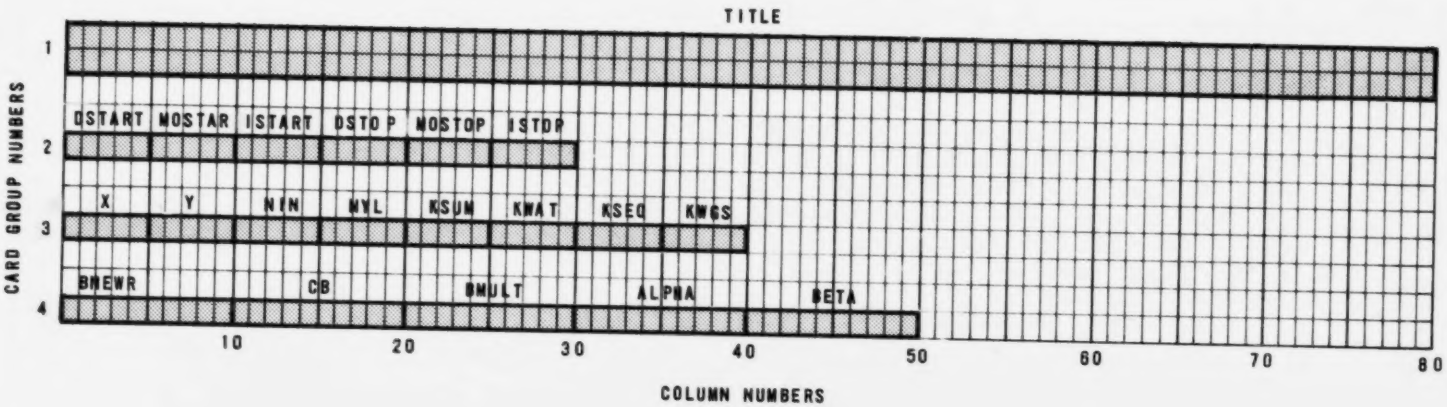

BNEWR, CB, BMULT, ALPHA, BETA
X, Y, NIN, NYL, KSUM, KWAT, KSEQ, KWGS
STARTING DATE, ENDING DATE
TITLE CARDS (2)

Figure 55. Data deck for VDAY.

Four categories of input data are required. They are: (1) user supplied titles for identification of the printout, (2) dates for the time period to be included in the printout, (3) input data and printout controls, and (4) overflow coliform computation



BLANK LINES HAVE BEEN INCLUDED BETWEEN INPUT DATA GROUPS FOR CLARITY OF FIGURE.
ACTUAL INPUT DATA SHOULD NOT HAVE BLANK LINES

Figure 56. VDAY input data cards format.

variables. The requirements for each of these categories will be discussed. Variable names will be capitalized.

Titles--

The titles (TITLE), two 80-character lines printed at the head of the printout, are used to simplify identification of the output. The information to be included in these two lines is left to the user to select and supply.

Selected Time Period--

If output information for a specific time period is desired, the beginning and end dates (inclusive) must be supplied. If these dates are left blank, the printout will cover the entire time period included in the EPAMAC file.

Input Data and Printout Controls--

The minimum volume (X) in Mgal that defines an overflow is required. Usually, this volume is 0 (zero) but it can be greater; this would be the case if the definition of an overflow was based on the volume exceeding a given volume.

The number of hours during which no overflow occurs (Y) between overflows is used to define the end of an overflow event. In other words, it is possible to define an overflow event as including one or more periods during which overflow occurred if the periods occur during the same storm event or if they are not separated by more than a given time period. For example, during the San Francisco study, a time period of 12 hours without any overflow was used to define an overflow event.

The input file number (NIN) is the tape or disk unit designation that matches the input file identified in the job control language. The last two digits (NYL) of the year for the first input date from tape or disk is also required.

Three flags are used to identify the individual summary tables to be included in the printout. Any combination of tables, or none at all, may be specified. The variables KSUM, KWAT, and KSEQ are used to specify summary tables for chronological calendar year, chronological water year, and water year ranked by annual hours the overflow is greater than X, respectively. Normally, these summary tables are not requested unless the user is interested in detailed information about overflow events during a given year.

KWGS is a flag used to identify the last input data set when multiple data sets are used during a run.

Example Input

The input variables for VDAY have been outlined above. Data card preparation and sequencing instructions for the complete VDAY program are given in Table 32 with the card groups highlighted.

A listing of actual data presented to the program for execution is shown in Figure 57. A verbal description of the implication of the data follows.

```
                                 DATA                                                     CARD GROUP
                                                                                            NUMBER

//GO.FT08F001 DD DSN=WYL.WS.C02.BQUAL.R1031.YEAR70,
//      UNIT=T6250,VOL=SER=AS1671,LABEL=13,DISP=OLD                                      JOB CONTROL
//GO.SYSIN DD *                                                                          JOB CONTROL
 VIOLATION DAY CALCULATION NORTHSIDE AREA  4 OVERFLOWS/YR @ 31 MGAL/D                         1
 T-90 = 70.2 HRS     ATTENUATION COEFFICIENT = VARIABLE     DATE 12-12-78                     1
    1     1    49    31    12    72                                                           2
 0.0     12     8    49     1     0     0 9999                                                3
      .0328   62.E 05         1.0 .00085107   0.82003                                         4
/*                                                                                       JOB CONTROL
```

Figure 57. Example input data - VDAY.

Job Control--

The following input specification applies:

- The input file, WYL.W8.C02.BQUAL.R1031.YEAR70, used to drive the program, is on a magnetic tape.

Execution Data--

The following execution input data apply:

- Title information for printout identification is supplied (2 cards).
- The printout will cover the period from January 1, 1949 to December 31, 1972.
- The minimum volume used to define an overflow is 0.0 Mgal. The number of hours without overflow between overflow events is 12. The last two digits of the year for the first input from tape or disk for the period desired for printout are 49. The chronological summary table is the only one of the three summary tables to be

Table 32. VDAY CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1	20A4	1-80	Title cards: two cards with heading to be printed on output	TITLE	None
2	6I5	1-5	Day for start of desired time period	DSTART	None
		6-10	Month for start of desired time period	MOSTAR	None
		11-15	Year for start of desired time period (last two digits)	ISTART	None
		16-20	Day for end of desired time period	DSTOP	None
		21-25	Month for end of desired time period	MOSTOP	None
		26-30	Year for end of desired time period (last two digits)	ISTOP	None
3	F5.2	1-5	Minimum overflow volume, Mgal	X	0.0
	7I5	6-10	Number of hours without overflow between overflow events	Y	None
		11-15	Input tape or disk assignment (for EPAMAC file)	NIN	None
		16-20	Last two digits of the year for the first input from tape or disk	NYL	None
		21-25	Flag for printing summary table = 0, skip printing = 1, print table	KSUM	0
		26-30	Flag for printing water year summary table = 0, skip printing = 1, print table	KWAT	0
		31-35	Flag for printing sequenced water year summary table = 0, skip printing = 1, print table	KSEQ	0
		36-40	Last data card set identifier for multiple runs. (Insert 9999 for last data card set, otherwise leave blank.)	KWGS	None
4	F10.0	1-10	Flag for coliform die-off attenuation coefficient calculation, day^{-1} = 0.0, uses method developed by J.B. Gilbert & Associates [2] > 0.0, uses value supplied as a constant	BNEWR	0.0
	E10.0	11-20	Coliform concentration of the overflow, MPN/100 mL	CB	None
	3F10.0	21-30	Initial coliform concentration multiplier	BMULT	None
		31-40	Coliform concentration correction factor	ALPHA	None
		41-50	Coliform concentration exponentiation factor	BETA	None

printed. And finally, this is the last data set for the run.

- The overflow coliform computation variables are supplied.

Output Description

Several options are available to the user for output retrieval from VDAY. In the examples presented here, only selected illustrative ones are shown.

Input Data Summary--

An example of the input data summary table is shown in Figure 58. This portion of the printout is included so the user has all of the input parameters used for the run included with the results. This is particularly helpful when several runs are made using input data values that do not vary markedly.

```
          VIOLATION DAY CALCULATION NORTHSIDE AREA  4 OVERFLOWS/YR @ 31 MGAL/D
          T-90 = 70.2 HRS    ATTENUATION COEFFICIENT = VARIABLE    DATE 12-12-78

BEGINNING DATE:  1- 1-1949

ENDING DATE:    12-31-1972


X (MINIMUN OVERFLOW VOLUME, MGAL/DAY) =   0.0
Y (NO. OF HOURS W/O OVERFLOW BETWEEN OVERFLOW EVENTS) = 12
NIN (NO. OF INPUT FILE FROM TAPE OR DISK) =   8
NYL (LAST TWO DIGITS OF YEAR PRIOR TO STARTING YEAR) =  49
KSUM (0 = SKIP, 1 = PRINT SUMMARY TABLE) =   1
KWAT (0 = SKIP, 1 = PRINT WATER YEAR SUMMARY TABLE (CHRONOLOGICAL ORDER)) =   0
KSEQ (0 = SKIP, 1 = PRINT SEQUENCED WATER YEAR SUMMARY TABLE) =   0
KWGS (LAST DATA CARD SET IDENTIFIER) =  9999


ATTENUATION COEFFICIENT (BNEWR) =  0.0328
OVERFLOW COLIFORM (CB) IS 6.2000E+06 MPN/100 ML
INITIAL  COLIFORM CONCENTRATION MULTIPLIER (BMULT) IS    1.0E+00
COLIFORM CONCENTRATION CORRECTION FACTOR (ALPHA) IS  0.000851
COLIFORM CONCENTRATION EXPONENTIATION FACTOR (BETA) IS  0.820030
```

Figure 58. VDAY input data summary table example.

Summary Tables--

Three summary tables are available from which the user may choose none or any other combination. An example of a portion of the table showing the results for the chronological order by calendar year is presented in Figure 59. The tables show the chronological order by water year and the water years sequenced by month in the year with the greatest percentage of time as violation days.

Annual Overflow Characteristics Tables--

These tables are provided for five major receiving water coliform concentration limits: (1) body contact recreation--events greater than 10,000 MPN/100 mL; (2) body contact recreation--5-day median greater than 240 MPN/100 mL; (3) body contact recreation--30-day 20-percentile greater than 1,000 MPN/100 mL; (4) shellfish--30-day median greater than 70 MPN/100 mL; and (5) shellfish--30-day 10-percentile greater than 230 MPN/100 mL. For each of these categories, a series of tables are printed out based on chronological order by water year and on ranking by annual hours with overflow. Each table is also followed by two statistical summary tables, one showing percentiles based on an assumed arithmetic distribution and the other based on the actual ranked values. The example tables presented here are for body contact recreation--events greater than 10,000 MPN/100 mL.

Annual information on overflows and overflow events by chronological water year are presented in Figure 60. Examples of the statistical summaries based on arithmetic distribution and ranked values for the overflows by water year are shown in Figures 61 and 62, respectively. The statistical summary tables include information on the cumulative total, average, standard deviation, maximum, and minimum values for each of the columns. Also included in the statistical summary tables are percentile values from 5 to 95 in 5 percentile increments.

Monthly information on violation days for each year are listed in Figure 63. The example shown lists the data for the first 6 month of the water year (July through December). A similar table is included in the printout for the remaining 6 months but is not shown here.

These same tables are repeated where the water years are ranked by annual hours of overflow. However, no examples of these tables are included here.

```
                                          SUMMARY TABLE

                                          HOURS      DAYS                                       % OF        % OF
                                          WITH       WITH                                       TIME        MONTH
 CAL.       MONTH       DAYS    HOURS     OVFLOW     OVFLOW     NO. OF      NO. OF              OVFLOW       AS
 YEAR     ---------      IN     WITH      > 0.0      > 0.0      OVFLOW     VIOLATION            > 0.0     VIOLATION
 -----    NO.  NAME    MONTH    OFLOW     MGAL       MGAL       EVENTS       DAYS               MGAL        DAYS
          ---  ----    -----    -----     ------     ------     ------     ---------            ------    ---------

  1949      1   JAN      31       2         2          2          1            2                 0.3         6.5
  1949      2   FEB      28       0         0          0          0            0                 0.0         0.0
  1949      3   MAR      31       5         5          1          1            2                 0.7         6.5
  1949      4   APR      30       0         0          0          0            0                 0.0         0.0
  1949      5   MAY      31       0         0          0          0            0                 0.0         0.0
  1949      6   JUN      30       0         0          0          0            0                 0.0         0.0
  1949      7   JUL      31       0         0          0          0            0                 0.0         0.0
  1949      8   AUG      31       0         0          0          0            0                 0.0         0.0
  1949      9   SEP      30       0         0          0          0            0                 0.0         0.0
  1949     10   OCT      31       0         0          0          0            0                 0.0         0.0
  1949     11   NOV      30       1         1          1          1            0                 0.0         0.0
  1949     12   DEC      31       0         0          0          0            0                 0.1         0.0
  1950      1   JAN      31      13        13          5          3            0                 0.0         0.0
  1950      2   FEB      28       5         5          1          1            6                 1.7        19.4
  1950      3   MAR      31       0         0          0          0            1                 0.7         3.6
  1950      4   APR      30       0         0          0          0            0                 0.0         0.0
  1950      5   MAY      31       0         0          0          0            0                 0.0         0.0
  1950      6   JUN      30       0         0          0          0            0                 0.0         0.0
  1950      7   JUL      31       0         0          0          0            0                 0.0         0.0
  1950      8   AUG      31       0         0          0          0            0                 0.0         0.0
  1950      9   SEP      30       0         0          0          0            0                 0.0         0.0
  1950     10   OCT      31       5         5          1          1            0                 0.0         0.0
  1950     11   NOV      30      10        10          1          1            2                 0.7         6.5
  1950     12   DEC      31      15        15          2          2            2                 1.4         6.7
  1951      1   JAN      31       0         0          0          0            3                 2.0         9.7
  1951      2   FEB      28       6         6          2          1            0                 0.0         0.0
  1951      3   MAR      31       0         0          0          0            3                 0.9        10.7
  1951      4   APR      30       0         0          0          0            0                 0.0         0.0
  1951      5   MAY      31       0         0          0          0            0                 0.0         0.0
  1951      6   JUN      30       0         0          0          0            0                 0.0         0.0
  1951      7   JUL      31       0         0          0          0            0                 0.0         0.0
  1951      8   AUG      31       0         0          0          0            0                 0.0         0.0
  1951      9   SEP      30       0         0          0          0            0                 0.0         0.0
  1951     10   OCT      31       0         0          0          0            0                 0.0         0.0
  1951     11   NOV      30       0         0          0          0            0                 0.0         0.0
  1951     12   DEC      31      12        12          4          3            0                 0.0         0.0
  1952      1   JAN      31      21        21          5          6            8                 1.6        25.8
  1952      2   FEB      29       0         0          0          0            9                 2.8        29.0
  1952      3   MAR      31       5         5          2          1            0                 0.0         0.0
  1952      4   APR      30       0         0          0          0            3                 0.7         9.7
  1952      5   MAY      31       0         0          0          0            0                 0.0         0.0
  1952      6   JUN      30       0         0          0          0            0                 0.0         0.0
```

Figure 59. Violation day summary table example (chronological order).

```
          ANNUAL OVERFLOW CHARACTERISTICS   --  BODY CONTACT RECREATION --  EVENTS GREATER THAN 10,000 MPN/100 ML

(CHRONOLOGICAL ORDER BY WATER YEAR)

---------------------------------------------------------------------------------------------------------------------
                                                 1ST MONTH
                                           --------------------
                 ANN
                HOURS                                % OF HRS
       ANN      OVFL    ANN    ANN             HOURS IN MONTH    ANN DAYS                 DAYS OVERFLOW > 0.0  MGAL
WATER OVFL    > 0.0   OVFLOW  VIOL             OVFL     OVFL       OVFL    ------------------------------------------------------------
YEAR   HRS     MGAL   EVENTS  DAYS     MON    > 0.0    > 0.0      > 0.0                               MONTH
                                               MGAL     MGAL       MGAL     JUL  AUG  SEP  OCT  NOV  DEC  JAN  FEB  MAR  APR  MAY  JUN
----- ----  ------  ------  ----     ---   ------  --------   --------    ---  ---  ---  ---  ---  ---  ---  ---  ---  ---  ---  ---

1949    19      19       5     7     JUL      0       0.0          7       0    0    0    0    1    0    5    1    0    0    0    0
1950    36      36       5    10     JUL      0       0.0          6       0    0    0    1    1    2    0    2    0    0    0    0
1951    38      38      10    20     JUL      0       0.0         11       0    0    0    0    0    4    5    0    2    0    0    0
1952    24      24       6    16     JUL      0       0.0          7       0    0    0    0    1    5    0    0    0    1    0    0
1953     0       0       0     0     JUL      0       0.0          0       0    0    0    0    0    0    0    0    0    0    0    0
1954     5       5       2     4     JUL      0       0.0          2       0    0    0    0    0    2    0    0    0    0    0    0
1955    41      41       5    11     JUL      0       0.0          8       0    0    0    0    0    6    2    0    0    0    0    0
1956     2       2       1     2     JUL      0       0.0          1       0    0    0    0    0    0    1    0    0    0    0    0
1957    38      38       9    18     JUL      0       0.0         11       0    0    1    2    0    1    1    2    1    3    0    0
1958     5       5       2     3     JUL      0       0.0          2       0    0    0    0    0    0    2    0    0    0    0    0
1959    10      10       3     5     JUL      0       0.0          3       0    0    1    0    0    1    0    1    0    0    0    0
1960    12      12       3     5     JUL      0       0.0          4       0    0    0    0    1    1    2    0    0    0    0    0
1961    17      17       5     7     JUL      0       0.0          6       0    0    0    0    1    1    0    2    2    0    0    0
1962    44      44       6    12     JUL      0       0.0          7       0    0    0    3    0    0    1    1    2    0    0    0
1963     4       4       1     3     JUL      0       0.0          1       0    0    0    0    0    0    1    0    0    0    0    0
1964     1       1       1     1     JUL      0       0.0          1       0    0    0    1    0    0    0    0    0    0    0    0
1965     9       9       3     3     JUL      0       0.0          3       0    0    0    0    0    1    2    0    0    0    0    0
1966    32      32       4     8     JUL      0       0.0          5       0    0    0    0    0    0    4    0    0    1    0    0
1967    11      11       3     6     JUL      0       0.0          4       0    0    0    0    0    0    3    0    1    0    0    0
1968     9       9       1     3     JUL      0       0.0          2       0    0    0    0    0    0    2    0    0    0    0    0
1969    28      28       6    14     JUL      0       0.0          7       0    0    0    1    0    1    4    0    1    0    0    0
1970    15      15       3     6     JUL      0       0.0          4       0    0    0    0    3    0    0    0    1    0    0    0
1971     0       0       0     0     JUL      0       0.0          0       0    0    0    0    0    0    0    0    0    0    0    0
```

Figure 60. Annual overflow characteristics table example (chronological order by water year).

```
           ANNUAL OVERFLOW CHARACTERISTICS   --  BODY CONTACT RECREATION --  EVENTS GREATER THAN 10,000 MPN/100 ML

(CHRONOLOGICAL ORDER BY WATER YEAR)

(PERCENTILES BASED ON ASSUMED ARITHMETIC DISTRIBUTION)

---------------------------------------------------------------------------------------------------------------------------------------------------
                                               1ST MONTH
                                      ----------------------
            ANN                                   % OF HRS
           HOURS                          HOURS  IN MONTH       ANN DAYS                       DAYS OVERFLOW > 0.0  MGAL
      ANN  OVFL    ANN    ANN              OVFL      OVFL           OVFL    -----------------------------------------------------------------------
WATER OVFL > 0.0 OVFLOW   VIOL            > 0.0     > 0.0          > 0.0                                  MONTH
YEAR   HRS  MGAL EVENTS   DAYS     MON     MGAL      MGAL           MGAL     JUL   AUG   SEP   OCT   NOV   DEC   JAN   FEB   MAR   APR   MAY   JUN
----- ---- ------ ------  ----     ---   ------  --------       --------     ---   ---   ---   ---   ---   ---   ---   ---   ---   ---   ---   ---


TOT   400.   400.    84.   164.            0.       0.0           102.      0.    0.    2.    8.    8.   25.   35.    9.   10.    5.    0.    0.

AVG   17.4   17.4    3.7    7.1           0.0       0.0            4.4     0.0   0.0   0.1   0.3   0.3   1.1   1.5   0.4   0.4   0.2   0.0   0.0

SIG   14.6   14.6    2.7    5.7           0.0       0.0            3.2     0.0   0.0   0.3   0.8   0.7   1.7   1.7   0.7   0.7   0.7   0.0   0.0

MAX    44.    44.    10.    20.            0.       0.0            11.      0.    0.    1.    3.    3.    6.    5.    2.    2.    3.    0.    0.

MIN     0.     0.     0.     0.            0.       0.0             0.      0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.


95%   41.4   41.4    8.0   16.5           0.0       0.0            9.7     0.0   0.0   0.6   1.6   1.5   3.9   4.3   1.6   1.6   1.3   0.0   0.0
90%   36.1   36.1    7.1   14.4           0.0       0.0            8.6     0.0   0.0   0.5   1.3   1.3   3.3   3.7   1.3   1.4   1.1   0.0   0.0
85%   32.5   32.5    6.4   13.0           0.0       0.0            7.8     0.0   0.0   0.4   1.2   1.1   2.9   3.3   1.1   1.2   0.9   0.0   0.0
80%   29.7   29.7    5.9   11.9           0.0       0.0            7.1     0.0   0.0   0.3   1.0   0.9   2.5   2.9   1.0   1.0   0.8   0.0   0.0
75%   27.3   27.3    5.4   11.0           0.0       0.0            6.6     0.0   0.0   0.3   0.9   0.8   2.2   2.7   0.9   0.9   0.7   0.0   0.0
70%   25.1   25.1    5.0   10.1           0.0       0.0            6.1     0.0   0.0   0.2   0.8   0.7   2.0   2.4   0.8   0.8   0.6   0.0   0.0
65%   23.0   23.0    4.7    9.3           0.0       0.0            5.7     0.0   0.0   0.2   0.6   0.6   1.7   2.2   0.7   0.7   0.5   0.0   0.0
60%   21.1   21.1    4.3    8.6           0.0       0.0            5.2     0.0   0.0   0.2   0.5   0.5   1.5   1.9   0.6   0.6   0.4   0.0   0.0
55%   19.2   19.2    4.0    7.8           0.0       0.0            4.8     0.0   0.0   0.1   0.4   0.4   1.3   1.7   0.5   0.5   0.3   0.0   0.0
50%   17.4   17.4    3.7    7.1           0.0       0.0            4.4     0.0   0.0   0.1   0.3   0.3   1.1   1.5   0.4   0.4   0.2   0.0   0.0
45%   15.6   15.6    3.3    6.4           0.0       0.0            4.0     0.0   0.0   0.1   0.3   0.3   0.9   1.3   0.3   0.3   0.1   0.0   0.0
40%   13.7   13.7    3.0    5.7           0.0       0.0            3.6     0.0   0.0   0.0   0.2   0.2   0.7   1.1   0.2   0.3   0.0   0.0   0.0
35%   11.8   11.8    2.6    4.9           0.0       0.0            3.2     0.0   0.0  -0.0   0.0   0.1   0.4   0.9   0.1   0.2  -0.0   0.0   0.0
30%    9.7    9.7    2.3    4.1           0.0       0.0            2.7     0.0   0.0  -0.1  -0.1  -0.0   0.2   0.6   0.0   0.1  -0.1   0.0   0.0
25%    7.5    7.5    1.9    3.3           0.0       0.0            2.3     0.0   0.0  -0.1  -0.2  -0.1  -0.1   0.4  -0.1  -0.1  -0.2   0.0   0.0
20%    5.1    5.1    1.4    2.3           0.0       0.0            1.7     0.0   0.0  -0.2  -0.3  -0.3  -0.3   0.1  -0.2  -0.2  -0.3   0.0   0.0
15%    2.2    2.2    0.9    1.2           0.0       0.0            1.1     0.0   0.0  -0.2  -0.5  -0.4  -0.7  -0.2  -0.4  -0.3  -0.5   0.0   0.0
10%   -1.3   -1.3    0.2   -0.2           0.0       0.0            0.3     0.0   0.0  -0.3  -0.6  -0.6  -1.1  -0.6  -0.5  -0.5  -0.6   0.0   0.0
 5%   -6.7   -6.7   -0.7   -2.2           0.0       0.0           -0.9     0.0   0.0  -0.4  -0.9  -0.8  -1.7  -1.2  -0.8  -0.8  -0.9   0.0   0.0
```

Figure 61. Annual overflow characteristics statistical table example (arithmetic distribution).

```
        ANNUAL OVERFLOW CHARACTERISTICS   --  BODY CONTACT RECREATION --  EVENTS GREATER THAN 10,000 MPN/100 ML

(CHRONOLOGICAL ORDER BY WATER YEAR)

(PERCENTILES BASED ON RANKED VALUES)

-----------------------------------------------------------------------------------------------------------------------
                                       1ST MONTH
                                 ---------------------
            ANN                             % OF HRS
           HOURS                      HOURS IN MONTH    ANN DAYS                 DAYS OVERFLOW > 0.0  MGAL
      ANN  OVFL   ANN    ANN           OVFL     OVFL       OVFL    --------------------------------------------------
WATER OVFL > 0.0 OVFLOW VIOL          > 0.0    > 0.0      > 0.0                         MONTH
YEAR  HRS  MGAL  EVENTS DAYS    MON   MGAL     MGAL       MGAL     JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
----- ---- ----- ------ ----    ---  ------  --------   --------   --- --- --- --- --- --- --- --- --- --- --- ---


TOT   400. 400.   84.   164.            0.      0.0        102.     0.  0.  2.  8.  8. 25. 35.  9. 10.  5.  0.  0.

AVG   17.4 17.4   3.7   7.1            0.0      0.0         4.4    0.0 0.0 0.1 0.3 0.3 1.1 1.5 0.4 0.4 0.2 0.0 0.0

SIG   14.6 14.6   2.7   5.7            0.0      0.0         3.2    0.0 0.0 0.3 0.8 0.7 1.7 1.7 0.7 0.7 0.7 0.0 0.0

MAX    44.  44.   10.   20.             0.      0.0         11.     0.  0.  1.  3.  3.  6.  5.  2.  2.  3.  0.  0.

MIN     0.   0.    0.    0.             0.      0.0          0.     0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.

95%     44   44    10    20              0      0.0          11      0   0   1   3   3   6   5   2   2   3   0   0
90%     41   41     9    18              0      0.0          11      0   0   1   2   1   5   5   2   2   1   0   0
85%     38   38     6    16              0      0.0           8      0   0   0   1   1   4   4   2   2   1   0   0
80%     38   38     6    14              0      0.0           7      0   0   0   1   1   2   4   1   1   0   0   0
75%     32   32     5    11              0      0.0           7      0   0   0   0   1   1   2   1   1   0   0   0
70%     28   28     5    10              0      0.0           7      0   0   0   0   0   1   2   0   1   0   0   0
65%     24   24     5     8              0      0.0           6      0   0   0   0   0   1   2   0   0   0   0   0
60%     19   19     5     7              0      0.0           6      0   0   0   0   0   1   2   0   0   0   0   0
55%     17   17     4     7              0      0.0           5      0   0   0   0   0   1   2   0   0   0   0   0
50%     12   12     3     6              0      0.0           4      0   0   0   0   0   0   1   0   0   0   0   0
45%     11   11     3     5              0      0.0           4      0   0   0   0   0   0   1   0   0   0   0   0
40%     10   10     3     5              0      0.0           3      0   0   0   0   0   0   1   0   0   0   0   0
35%      9    9     3     4              0      0.0           3      0   0   0   0   0   0   0   0   0   0   0   0
30%      9    9     2     3              0      0.0           2      0   0   0   0   0   0   0   0   0   0   0   0
25%      5    5     1     3              0      0.0           2      0   0   0   0   0   0   0   0   0   0   0   0
20%      4    4     1     3              0      0.0           1      0   0   0   0   0   0   0   0   0   0   0   0
15%      2    2     1     2              0      0.0           1      0   0   0   0   0   0   0   0   0   0   0   0
10%      1    1     1     1              0      0.0           1      0   0   0   0   0   0   0   0   0   0   0   0
 5%      0    0     0     0              0      0.0           0      0   0   0   0   0   0   0   0   0   0   0   0
```

Figure 62. Annual overflow characteristics statistical table example (ranked values).

```
        ANNUAL OVERFLOW CHARACTERISTICS   -- BODY CONTACT RECREATION --  EVENTS GREATER THAN 10,000 MPN/100 ML

(CHRONOLOGICAL ORDER BY WATER YEAR)

---------------------------------------------------------------------------------------------------------------------------------------

           HOURS                      JUL               AUG               SEP               OCT               NOV               DEC
            OVFL   ANN   ANN     --------------    --------------    --------------    --------------    --------------    --------------
WATER OVFL > 0.0  OVFLOW VIOL        VIOL  % OF        VIOL  % OF        VIOL  % OF        VIOL  % OF        VIOL  % OF        VIOL  % OF
YEAR  HRS   MGAL  EVENTS DAYS    MON DAYS MONTH    MON DAYS MONTH    MON DAYS MONTH    MON DAYS MONTH    MON DAYS MONTH    MON DAYS MONTH
----- ---- ------ ------ ----    --- ---- -----    --- ---- -----    --- ---- -----    --- ---- -----    --- ---- -----    --- ---- -----

1949    19     19      5    7    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1950    36     36      5   10    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    2   6.5    NOV    2   6.7    DEC    3   9.7
1951    38     38     10   20    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    8  25.8
1952    24     24      6   16    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    2   6.7    DEC   10  32.3
1953     0      0      0    0    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1954     5      5      2    4    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    4  12.9
1955    41     41      5   11    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    7  22.6
1956     2      2      1    2    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1957    38     38      9   18    JUL    0   0.0    AUG    0   0.0    SEP    1   3.3    OCT    2   6.5    NOV    0   0.0    DEC    1   3.2
1958     5      5      2    3    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1959    10     10      3    5    JUL    0   0.0    AUG    0   0.0    SEP    4  13.3    OCT    0   0.0    NOV    0   0.0    DEC    1   3.2
1960    12     12      3    5    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    2   6.5
1961    17     17      5    7    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    2   6.5
1962    44     44      6   12    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    6  19.4    NOV    3  10.0    DEC    0   0.0
1963     4      4      1    3    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1964     1      1      1    1    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    1   3.2    NOV    0   0.0    DEC    0   0.0
1965     9      9      3    3    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    2   6.5
1966    32     32      4    8    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1967    11     11      3    6    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1968     9      9      1    3    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
1969    28     28      6   14    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    3   9.7    NOV    0   0.0    DEC    4  12.9
1970    15     15      3    6    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    2   6.7    DEC    2   6.5
1971     0      0      0    0    JUL    0   0.0    AUG    0   0.0    SEP    0   0.0    OCT    0   0.0    NOV    0   0.0    DEC    0   0.0
```

Figure 63. Monthly violation day data summary table example (chronological order by water year).

Interpretation of Results

From Figure 60, the annual number of hours during which overflow occurs ranges from a high of 44 to a low of 0. The annual number of overflow events varies from 10 to 0. The highest number of overflow events, 10, occurs during the 1951 water year while the highest annual hours with overflow, 44, occurs in 1962. There were no overflows during May, June, July, and August for the period selected. The months with the highest number of days with overflows were December and January.

Data on the number of violation days for each month during the period are shown in Figure 63. The percent of time during each month represented by the violation days is shown also. Note that in this figure, most of the violation days occur in November and December with approximately 32% of the days in December of the 1952 water year being violation days.

SECTION 12

TECHNICAL CONCEPTS

The theories, assumptions, and limitations inherent with EPAMAC and the postprocessors have been briefly discussed in earlier sections of this report. They are presented here in slightly more detail and in one location for ease of reference.

EPAMAC

The EPAMAC model is founded on relatively simple theories. The theoretical basis and associated assumptions and limitations are discussed first for the main model and then for the postprocessor programs.

Theory

The fundamental theory behind EPAMAC is the rational method of computing runoff. The rational formula relates flow to contributing area, rainfall intensity, and perviousness of the surface area. The formula is expressed as:

$$Q = CiA \qquad (2)$$

where Q = flow, ft^3/s (cm·ha/h)

C = runoff coefficient, fraction of rain that appears as a direct runoff

i = rain intensity, in./h (cm/h)

A = area, acres (ha)

By using continuous rainfall records, the method can be used to approximate a continuous simulation model.

The rational method is most appropriately used in urban areas of less than 100 acres (41 ha), or where runoff is spread over the surface and collected in numerous inlets [1]. The method is somewhat simplistic since it combines all the factors influencing perviousness into one coefficient, and expresses runoff as a fraction of total rainfall neglecting losses that would reduce the rainfall available for the calculation. The simplicity is appropriate for EPAMAC as it is a broad scale model.

Another theory used in EPAMAC involves mixing in storage. The complete mix theory purports the idea that flow and the associated pollutants are immediately dispersed throughout storage. The particles then leave in proportion to the average concentration and flow volume removed from storage at any time step. A different mixing theory, plug flow, might also have been used in the model. Plug flow states flow and pollutants are removed in the same sequence in which they entered. Complete-mix was chosen because (1) the implementation in a model is much simpler, and (2) the actual mixing phenomenom is expected to show a combination of plug and complete mix characteristics.

Sedimentation theory is involved in estimating percent removal of solids from storage. The theoretical settling velocity of a material in water is a function of particle size, shape, and specific weight. Other factors such as turbulence and horizontal velocity affect how a particle will actually settle in a transport or storage facility. To determine the settling velocity of particles an analysis could be conducted based on Stokes Law for spherical particles:

$$V_s = D^2 \frac{(\gamma_s - \gamma_w)}{18\mu} \qquad (3)$$

where V_s = fall velocity, ft/s (m/s)

D = sphere diameter, ft (m)

γ_s = specific weight of sphere, lb/ft^3 (kg/m^2)

γ_w = specific weight of fluid, lb/ft^3 (kg/m^3)

μ = fluid viscosity, $lb/ft^2 \cdot s$ ($N/m^2 \cdot s$)

However, settling velocities can also be approximated by experimental methods. Various authors have conducted settling columns tests to establish vertical velocity and particle distribution curves [2, 3, 4], see Figure 64. Rather than conduct an extensive numerical analysis, reported curves or, preferably, curves established by experimentation on local wastewater can be used to estimate sedimentation in storage.

For continuous flow sedimentation with a uniform horizontal velocity in the basin, the theoretical removal efficiency of the basin can be calculated. All particles having a settling velocity, Vs, greater than or equal to the depth of the tank divided by the detention time will settle to the bottom of the tank. The minimum settling velocity for which all particles will be removed can also be calculated, referring to Figure 65, as follows:

$$V_s = \frac{V_{horiz}\, h}{L} \qquad (4)$$

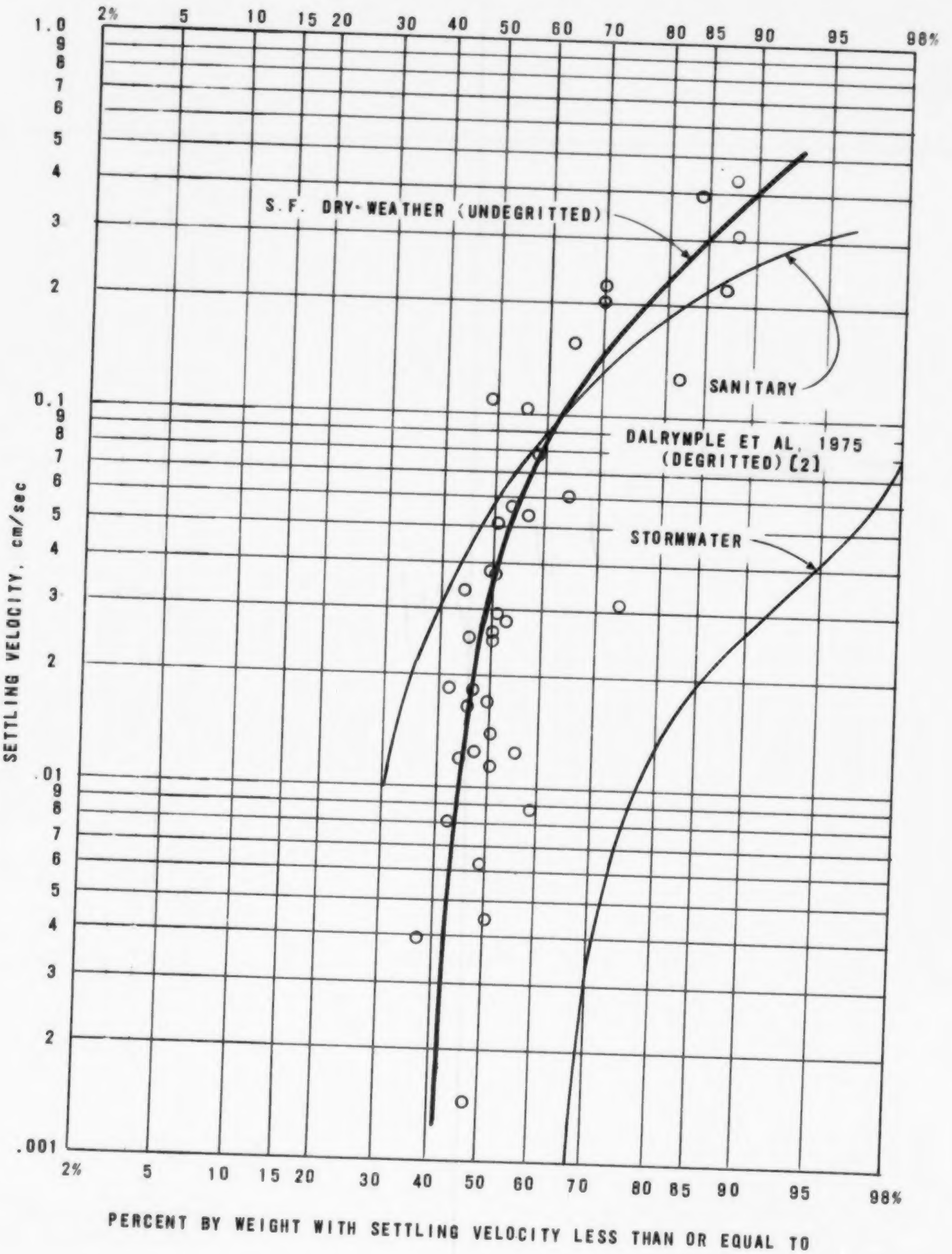


Figure 64. Settling velocity distribution of solids in San Francisco dry-weather sewage. 18 August 1978, 6:30 a.m.

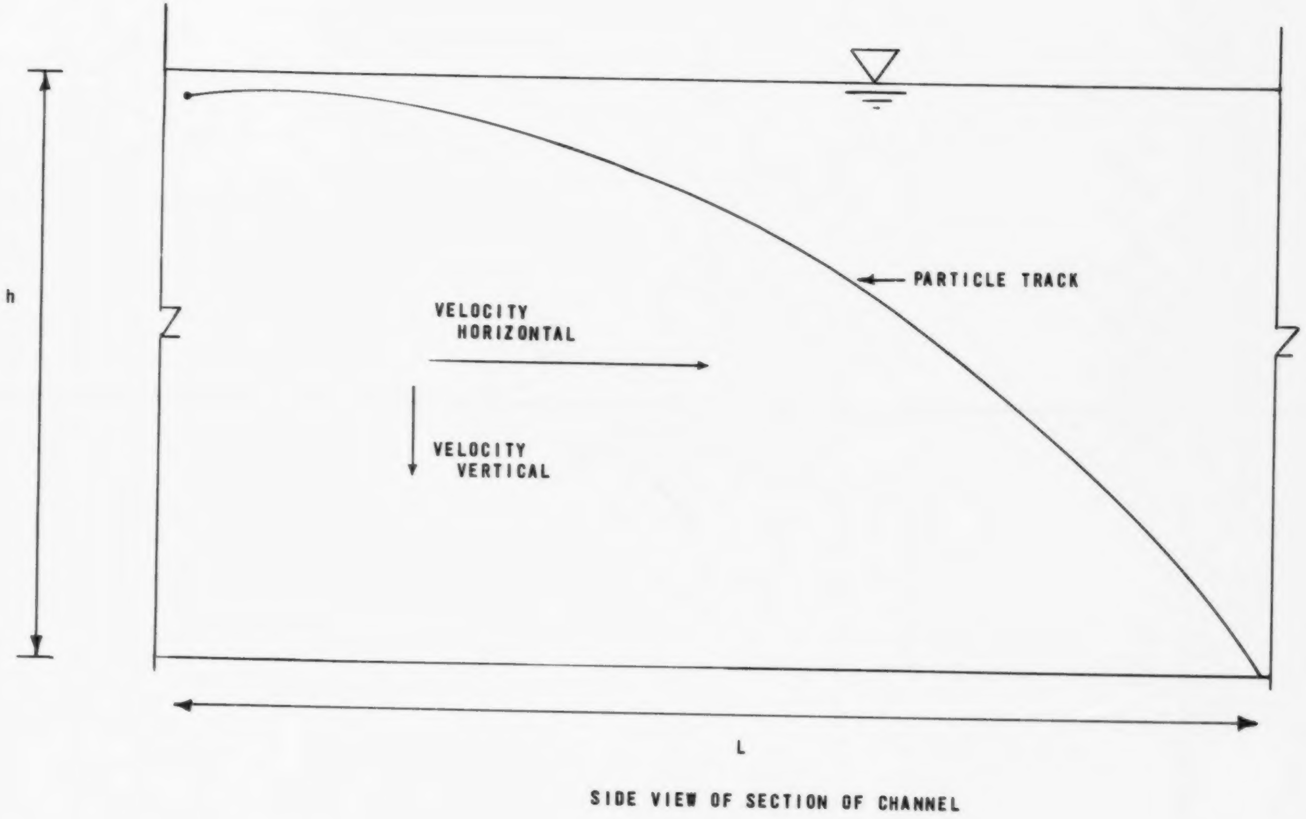


Figure 65. Motion of settling particle.

where h = depth of water, ft (m)

L = length of tank, ft (m)

V_{horiz} = horizontal flow velocity, ft/s (m/s)

A turbulence factor can also be included to more closely approach actual conditions. From a curve as shown in Figure 64, for any velocity, an estimate of the amount of solids removed can be determined and used as input for EPAMAC. The detailed procedure for making the estimate is presented in Appendix C.

Assumptions

Several assumptions were chosen to maintain the EPAMAC model simplicity and serviceability. The assumptions (including expanded discussions for those which may not be obvious) are listed below:

- The runoff coefficient remains constant for all storms on a given watershed. The intent is that natural variations average out over long periods of analysis.
- Other rational method factors involving rainfall intensity variation and antecedent soil moisture conditions are adequately addressed by the runoff coefficient and also average out over long periods of analysis.
- The rational method is appropriate for use in EPAMAC.
- Complete mixing in storage is a reasonable model of flow character.
- Pollutants are conservative and do not degrade.
- Treatment removal efficiencies are constant over varying flowrates. The basis for this assumption is the need for simplicity and the effect of long periods of record averaging out anomalies.
- Storage removal efficiencies are constant over varying overflow rates.
- Wet-weather quality is expressed as one average value except during the first 2 hours of a storm. If desired, the first 2 hours can be of higher concentration to model first flush effects. The first flush peak concentrations occur in the first 2 hours of a storm.

Limitations

As a consequence of the simplifying assumptions, the program should be executed using not less than 10 to 20 years of rainfall record to provide reasonable accuracy. Shorter periods of record can be used, but the results may be less representative.

Other limitations of EPAMAC include:

- BOD and SS are the only pollutants modeled.
- Wet-weather quality is based on one to three input values.
- Selective error checking of input data (basics only) is included.
- Input cards must be repeated for each subarea.
- Printout is in units of Mgal, klb, and mg/L only.
- A maximum of four lateral inflows is allowed.
- Daily and hourly printout is only generally representative of conditions being modeled. Values from shorter periods than monthly summaries should be used with caution.

The last item is only a limitation if the user is attempting to use the program at a level of detail beyond the claims of the program. If the user wishes to select specific design parameters, the use of other models would be more appropriate.

HISTO

The HISTO program is simply a data transformation program. It takes the input data and prints that data in a new format, namely histogram plots and range summary tables.

VDAY

The VDAY program is founded on relatively simple theories. The theoretical basis and associated assumptions and limitations are discussed here.

Theory

The fundamental theory behind VDAY is that the time variation of the concentration of coliform organisms in the receiving water after an overflow event follows Chick's Law [5]. In other words, the longer the time since the end of the overflow, the greater the die-off of the organisms.

The calculation of the number of coliforms in the receiving water resulting from an overflow is based on the following equation:

$$N = OC_ok \qquad (5)$$

where N = number of coliforn organisms

O = overflow volume, acre-inch (ha cm)

C_o = coliform concentration in the overflow, MPN/100 mL

k = constant, MPN-acre-inch/100 mL (MPN ha cm/100 mL)

The concentration of coliform in the receiving water is calculated using the equation:

$$C_r = N^{\beta}\alpha B \qquad (6)$$

where C_r = coliform concentration in the receiving water, MPN/100 mL

N = organisms in the overflow, MPN

β = coliform concentration exponentiation factor, h^{-1}

α = coliform concentration correction factor

B = coliform concentration multiplier

The decay in the receiving water coliform concentration, based on Chick's Law, follows the equation:

$$C_t = C_r e^{-k_o t} \qquad (7)$$

where C_t = coliform concentration in the receiving water, MPN/100 mL

C_r = coliform concentration in the receiving water where t equals O, MPN/100 mL

k_o = coliform attenuation coefficient, h^{-1}

t = time since end of overflow, h

Equation 6 is an empirical equation developed by others [6] as part of a study of the effects of combined sewage overflows on receiving waters surrounding San Francisco. The coefficients in both Equations 6 and 7 were determined using regression analysis of existing receiving water coliform data.

Assumptions

During an overflow event, the number of coliforms discharged in the overflow during each hour is determined from Equation 5 and the coliform concentration in the receiving water is calculated using Equation 6. The concentration takes into account the background concentration in the receiving water at the beginning of the overflow. For each hour when there is no overflow, the coliform concentration in the receiving water as a result of the die-off is calculated using Equation 7. There is also a minimum background concentration below which the receiving water concentration cannot fall.

For the application in San Francisco, the coefficients for Equations 4, 5, and 6 were as follows:

Coefficient	Equation	Value	
β	12-5	0.346 0.82003	(ocean) (bay)
α	12-5	17.74 8.5107×10^{-4}	(ocean) (bay)
B	12-5	1.0	
k_o	12-6	0.328, or use Equation 7	

For San Francisco, it was found that the decay constant, k_o, in Equation 7 was a function of the overflow volume [6]. This relationship was found to be:

$$k_o = 0.0128 + 0.00421 \ln V \qquad (8)$$

where k_o = coliform attenuation coefficient, h^{-1}

V = total overflow volume, acre-in. (m^3)

The user should keep in mind that the values for α, β, and k_o were determined through regression analysis of data specific to San Francisco. The user should determine the appropriate values for these coefficients for the location where the program is being applied.

Limitations

Since VDAY uses data generated by EPAMAC as a data source, VDAY is subject to the same limitations as EPAMAC. VDAY is not meant to predict or model events in exact detail but to indicate average results over long periods. Additional limitations of VDAY include:

- Receiving water coliform concentration standard violation day criteria are specific to the City and County of San Francisco.
- Coliform concentration in the overflow is based on a single input variable.

- Receiving water coliform concentration attenuation rate can be a single input variable or based on the volume of the overflow at the user's option.

- Printout is in units of Mgal and violation days.

- Printout is on an annual basis and is only generally representative of conditions being modeled. Values from short time periods (less than 20 years) should be used with caution.

SECTION 13

PROGRAM DOCUMENTATION

The documentation of EPAMAC and the postprocessor programs includes examination of model operation, internal algorithms, logic flow charts, job control requirements, and input/output files. Information is included that will aid the user in installing the programs on a computer system. The EPAMAC program is discussed first.

EPAMAC PROGRAM

Mode of Operation

The EPAMAC model is a central part of stormwater facilities planning. The use of the model is illustrated in Figure 66. The cycle of executing the model, examining the results, and rerunning the model involves a desk-top type of approach. The run results guide the user in selection of facility sizes; however, the user must exercise judgment throughout the process by balancing storage and treatment capacities to arrive at a solution for the alternative being studied.

The EPAMAC model is fundamental to development of alternatives for comparison. However, the final comparison of alternatives is not based on EPAMAC results alone. The postprocessor information may be useful in comparing receiving water impacts; but final alternative selection is based on other factors such as social and environmental impact, cost, reliability, and public acceptability.

Program Functions, Internal Algorithms

The algorithms used in EPAMAC to compute the output results are presented now. Only major computational equations are included. Elements of the equations are expressed in descriptive terms rather than using variable names.

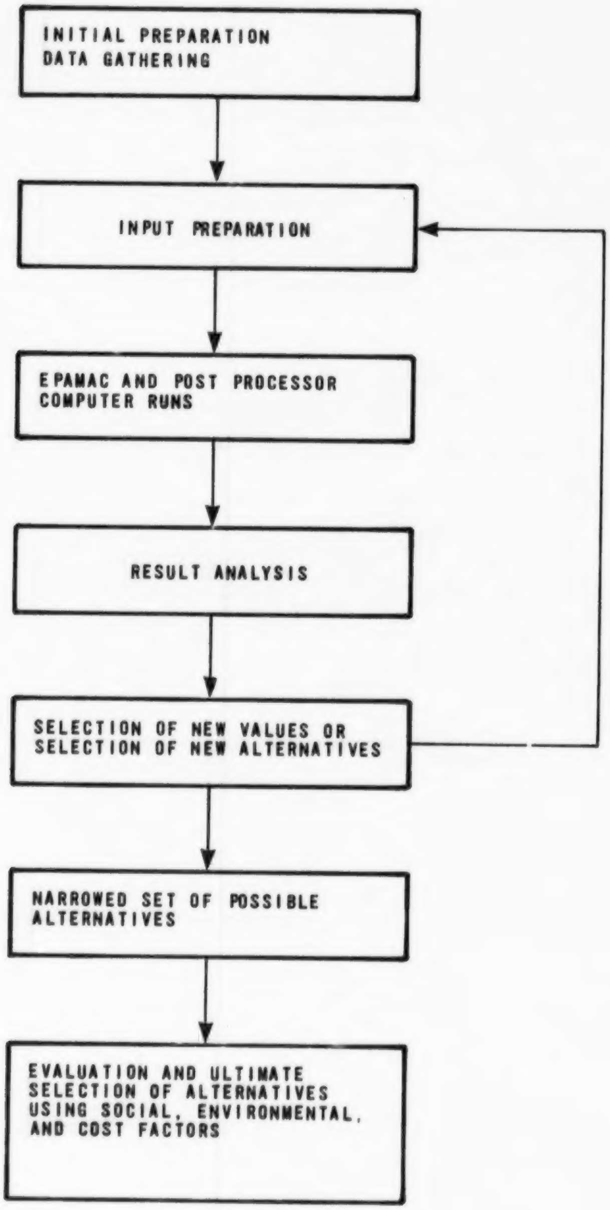

INITIAL PREPARATION
DATA GATHERING
INPUT PREPARATION
EPAMAC AND POST PROCESSOR COMPUTER RUNS
RESULT ANALYSIS
SELECTION OF NEW VALUES OR SELECTION OF NEW ALTERNATIVES
NARROWED SET OF POSSIBLE ALTERNATIVES
EVALUATION AND ULTIMATE SELECTION OF ALTERNATIVES USING SOCIAL, ENVIRONMENTAL, AND COST FACTORS

Figure 66. Relationship of EPAMAC application to planning process.

The first equation in EPAMAC is the calculation of average weighted runoff coefficient. Runoff coefficients and areas for each of the specified land uses are used. The equation is expressed as:

$$\text{Weighted runoff coefficient} = \frac{\sum_{i=1}^{6}(\text{area}_i \times \text{coeff}_i)}{\sum_{i=1}^{6} \text{area}_i} \qquad (9)$$

The next equation converts the input rain data to values more appropriate for a different watershed location. The rainfall multiplication factor is used in the equation:

$$\begin{aligned}\text{Calculated rain} = {} & \text{historical rainfall} \\ & \times \text{ rainfall multiplier}\end{aligned} \qquad (10)$$

The rainfall calculated in Equation 10 is used in Equation 11 to compute the runoff flow for each hour when rain occurs. The third equation is:

$$\begin{aligned}\text{Runoff volume} = {} & \text{calculated rainfall} \times \left(\sum_{i=1}^{6} \text{area}_i\right) \\ & \times \text{ weighted runoff coefficient}\end{aligned} \qquad (11)$$

The remaining equations in EPAMAC all involve pollutant load computations. Equations 12 and 13 are used to calculate the pollutant load in the runoff volume. The BOD and SS concentrations are selected depending on whether it is the first, second, or subsequent hour of a storm event. The two equations are:

$$\begin{aligned}\text{Hourly BOD load (1,000 lb)} = {} & \text{runoff volume (Mgal)} \\ & \times \text{ BOD concentration (mg/L)} \\ & \times\ 8.345/1{,}000\end{aligned} \qquad (12)$$

$$\begin{aligned}\text{Hourly SS load (1,000 lb)} = {} & \text{runoff volume (Mgal)} \\ & \times \text{ SS concentration (mg/L)} \\ & \times\ 8.345/1{,}000\end{aligned} \qquad (13)$$

Pollutant loads for the volume overflowing are calculated as shown in Equations 14 and 15. These equations are used independent of user selection of a percent removal of pollutants in storage to account for any sedimentation occurring in storage.

The mass of pollutants in storage is the summation of lateral inflow runoff and dry-weather pollutant contributions:

$$\text{BOD load in overflow (lb)} = \frac{\text{BOD in storage (lb)}}{\text{storage volume (Mgal)}} \times \text{overflow volume (Mgal)} \times (1 - \%\ \text{BOD removal in storage}/100)^{*} \qquad (14)$$

$$\text{SS load in overflow (lb)} = \frac{\text{SS in storage (lb)}}{\text{storage volume (Mgal)}} \times \text{overflow volume (Mgal)} \times (1 - \%\ \text{BOD removal in storage}/100)^{*} \qquad (15)$$

Equations 16 and 17 used to determine treated effluent pollutant loads are very similar to Equations 14 and 15 for pollutant loads in overflow volumes. The first component of the final terms in Equations 16 and 17 is identical to the first component in Equations 14 and 15 if no pollutant removal due to sedimentation in storage is specified. In the case where pollutant removal resulting from sedimentation in storage is specified, the bracketed expressions in Equations 16 and 17 also apply.

$$\text{BOD load in treated effluent (lb)} = \text{treated volume} \times (1 - \%\ \text{BOD removal}/100) \times \frac{\text{BOD in storage (lb)} - [\text{BOD in overflow (lb)}]^{*}}{\text{storage volume} - [\text{overflow volume}]^{*}} \qquad (16)$$

$$\text{SS load in treated effluent (lb)} = \text{treated volume} \times (1 - \%\ \text{SS removal}/100)\ \frac{\text{SS in storage (lb)} - [\text{SS in overflow (lb)}]^{*}}{\text{storage volume} - [\text{overflow volume}]^{*}} \qquad (17)$$

The user also has an alternate method of specifying quality of the treated volumes. A constant effluent quality concentration can be chosen instead of specifying a percent removal. The treated flow pollutant loads are then calculated in accordance with Equations 18 and 19.

$$\text{BOD load in treated effluent (1,000 lb)} = \text{treated volume (Mgal)} \times 8.345/1{,}000 \times \text{BOD effluent concentration (mg/L)} \qquad (18)$$

$$\text{SS load in treated effluent (1,000 lb)} = \text{treated volume (Mgal)} \times 8.345/1{,}000 \times \text{SS effluent concentration (mg/L} \qquad (19)$$

---

*This portion of the equation is used to account for sedimentation in storage only when the user specifies a percent removal for pollutants in storage.

These 11 equations constitute the primary calculations of EPAMAC. The location of each equation in the program logic will be identified next.

Program Logic Flow Charts

The EPAMAC program code can be separated into segments reflecting the logic of the program. Charts showing the progression of the logic in the MAIN program and the HOURLY subroutine are shown in Figures 67 and 68. This section discusses the major logic sections of both MAIN and HOURLY program segments.

MAIN Program Segment--

The MAIN program has the primary function of processing the input data and performing variable assignments. Equation 9 is the only major calculation executed in MAIN. As seen from Figure 67, most of the Main program code is executed once for each subarea in the EPAMAC run. The following discussion will sequentially discuss the segments shown in Figure 67.

The first functions of the MAIN program are to read Input Card Group 1, perform minor preliminary assignments, and declare and dimension variables. The information on Card Group 1 is global or universal since it pertains to all subareas in the EPAMAC run. All variable dimension and declaration statements are located at the beginning of the computer code.

Variable assignments based on the global information are located in this segment; for example, title print frequency is assigned a value of monthly, yearly, or one of the other three possible frequencies. Also, the simulation started identifier line and first output page heading are printed in the first logic segment.

The next segment of the program prints out the initial input data and checks to see if the rain file logical unit number is non-negative. After executing those functions, the program then enters a loop that is processed for each subarea. The first segment within the loop reads the subarea input data, (Card Groups 2 through 11). The second segment writes the input values to the printer. The third segment performs minor calculations and variable assignments based on the subarea input data. Functions typical of those performed in the third segment are:

- Compute average runoff coefficient using Equation 9.
- Test for runoff coefficient override.
- Check for consistency of pumping variables.
- Calculate dry-weather calculations from dry-weather load and flow values.

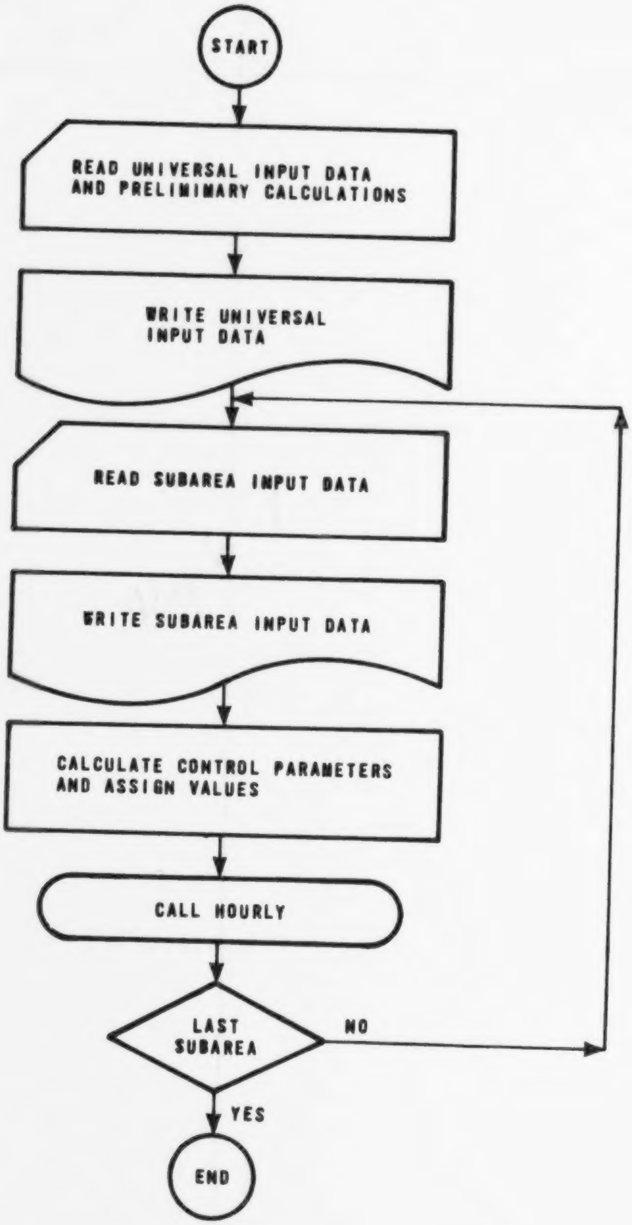

START
READ UNIVERSAL INPUT DATA AND PRELIMINARY CALCULATIONS
WRITE UNIVERSAL INPUT DATA
READ SUBAREA INPUT DATA
WRITE SUBAREA INPUT DATA
CALCULATE CONTROL PARAMETERS AND ASSIGN VALUES
CALL HOURLY
LAST SUBAREA
NO
YES
END

Figure 67. MAIN program segment.

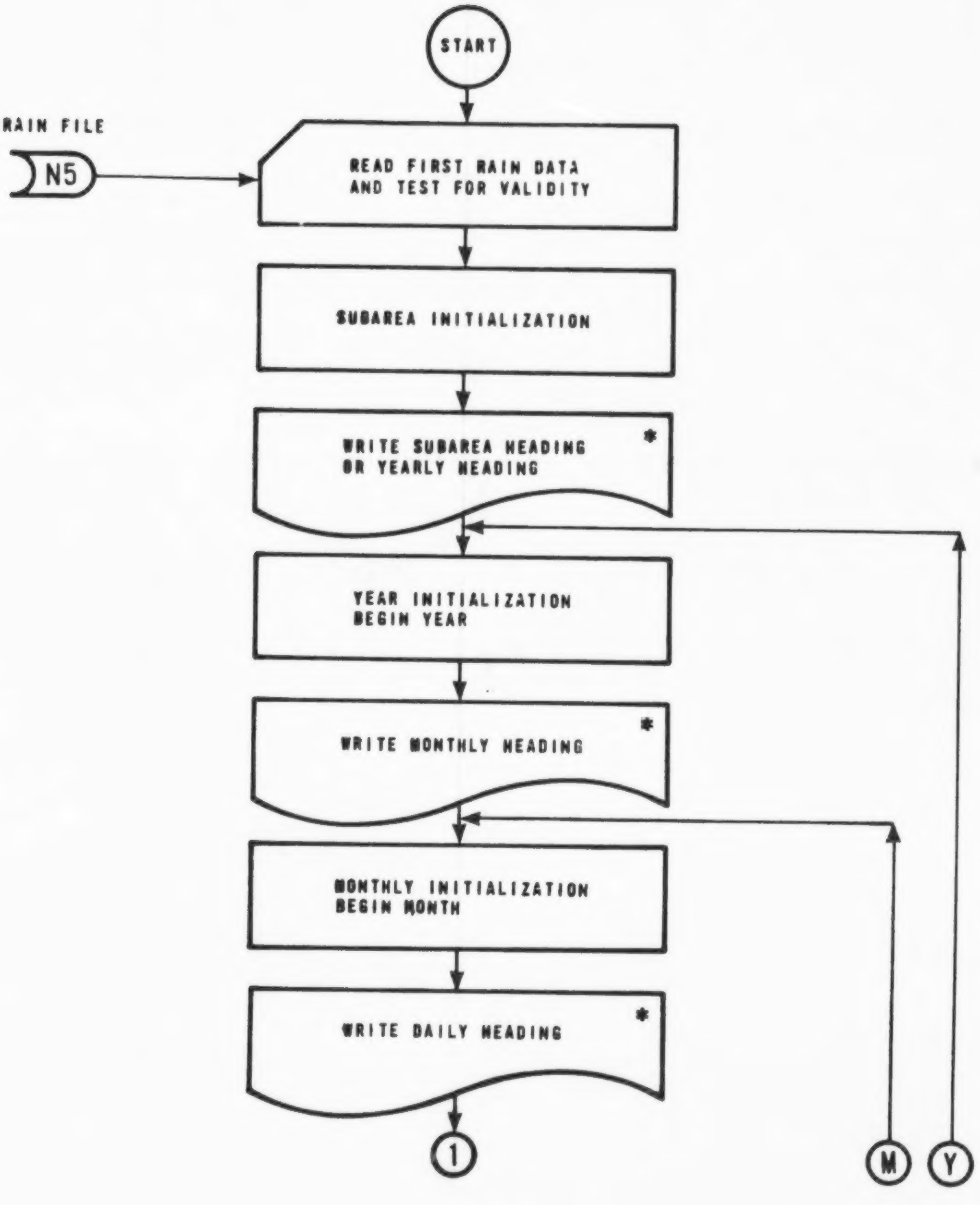
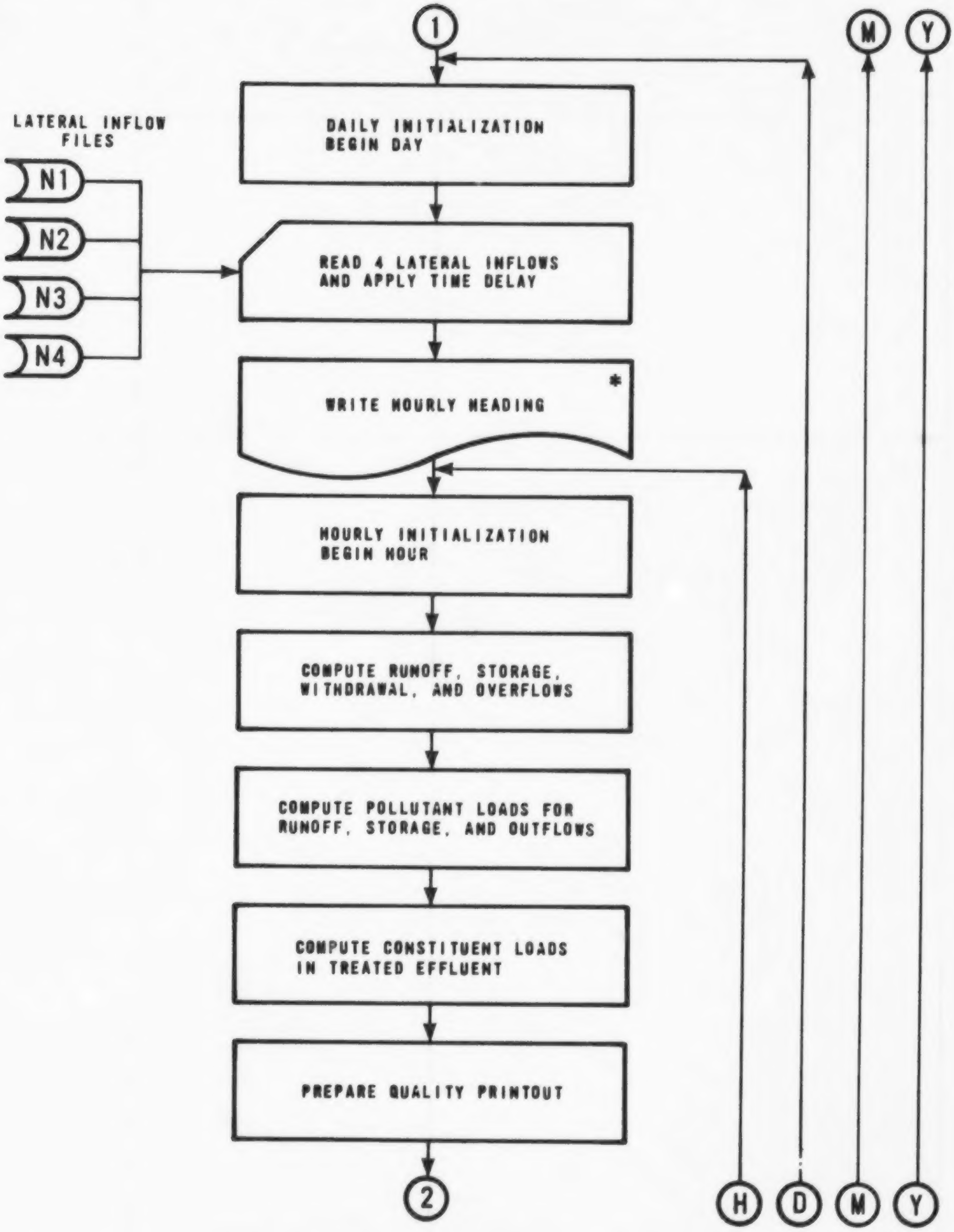

START
RAIN FILE
N5
READ FIRST RAIN DATA AND TEST FOR VALIDITY
SUBAREA INITIALIZATION
WRITE SUBAREA HEADING OR YEARLY HEADING
*
YEAR INITIALIZATION BEGIN YEAR
WRITE MONTHLY HEADING
*
MONTHLY INITIALIZATION BEGIN MONTH
WRITE DAILY HEADING
*
1
M
Y

Figure 68. HOURLY subroutine.



1
M
Y
LATERAL INFLOW FILES
N1
N2
N3
N4
DAILY INITIALIZATION BEGIN DAY
READ 4 LATERAL INFLOWS AND APPLY TIME DELAY
WRITE HOURLY HEADING
*
HOURLY INITIALIZATION BEGIN HOUR
COMPUTE RUNOFF, STORAGE, WITHDRAWAL, AND OVERFLOWS
COMPUTE POLLUTANT LOADS FOR RUNOFF, STORAGE, AND OUTFLOWS
COMPUTE CONSTITUENT LOADS IN TREATED EFFLUENT
PREPARE QUALITY PRINTOUT
2
H
D
M
Y

Figure 68 (continued)

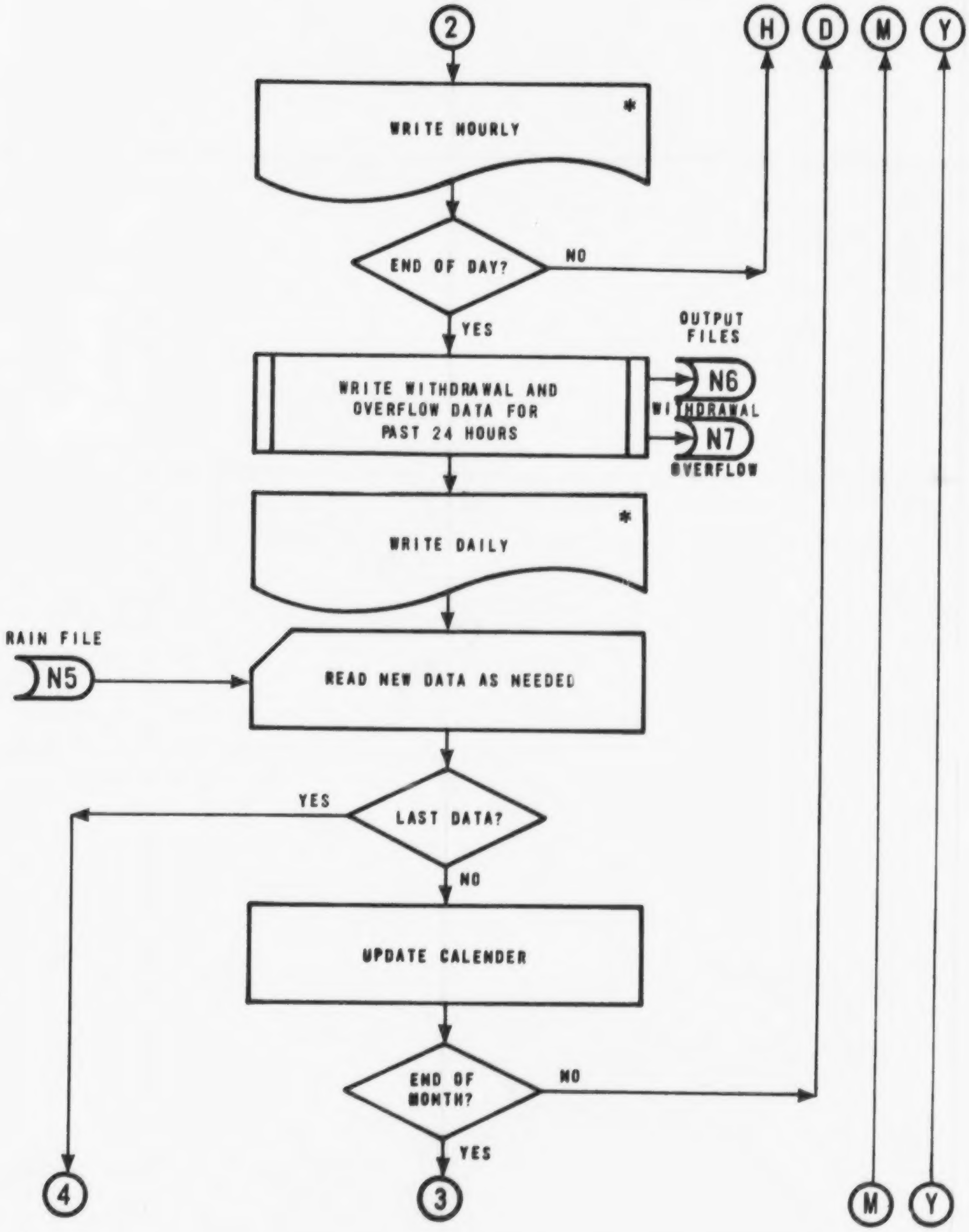


Figure 68 (continued)

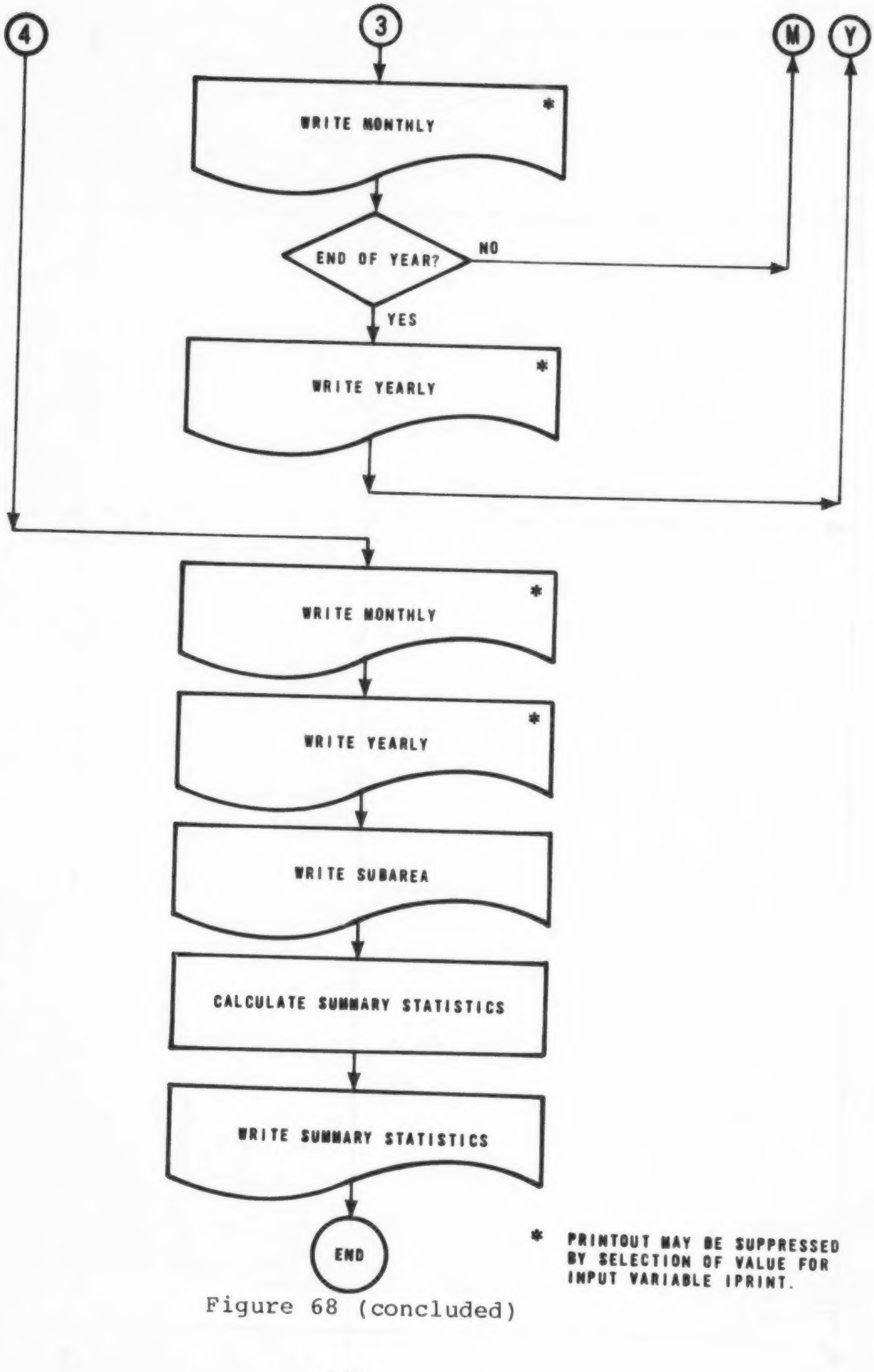


Figure 68 (concluded)

- Check lateral inflow unit numbers and travel delay values for error.

- Check Type C overflow event separation value for error.

Once the subarea input has been processed, subroutine HOURLY is called. Upon return from the subroutine, file pointers are updated and the program will process the next subarea or terminate if all subareas have been run. The MAIN program segment does not access any external file other than the input file.

HOURLY Subroutine--

The majority of EPAMAC computations are located in subroutine HOURLY. The subroutine is processed once for each subarea. HOURLY contains a series of logic loops. One loop occurs for each time step: hourly, daily, monthly, and yearly. These loops and the functions performed within them are shown in Figure 68. The following discussion will sequentially examine the HOURLY subroutine as presented in Figure 68.

The HOURLY subroutine begins by declaring variables, updating the rainfile pointer and reading the first rain data. The rain input file must be established and accessible before the first data are read. The program also checks the validity of the rain data date (for example, not having a date of February 31).

The next step in the subroutine is to initialize all subarea variables. This is followed by code to print either the subarea or yearly table heading. If neither of those two frequencies are chosen by the user, the code is skipped. Next begins the water year computational loop.

The first segment in the year loop initializes all variables relating to a yearly time step. The next segment contains the monthly table headings. Immediately following is the beginning of the monthly loop.

Variable initialization relating to monthly time step and the daily table headings are the subjects of the next two subroutine segments. Progressing through Figure 68 indicates the daily time step follows. The first function within the daily loop is the initialization of all variables that change on a daily basis. The major computation section begins after the initialization of the daily variables.

The next segment of subroutine HOURLY is the access point for the four lateral inflow files. The lateral inflow data are read and then compared with the current program clock date. If the dates do not match, an error is detected and an error message is printed. The program proceeds only if the dates are compatible.

When travel time delays have been specified, this segment also shifts the data the appropriate number of hours.

Once the lateral inflow processing is complete, the program prints out the hourly heading (when selected) and proceeds with the hourly loop. The first step in the loop is to initialize all hourly variables. The program segments thus far have been primarily devoted to printing table headings and initializing variables. The next three segments in the hourly loop are primarily devoted to computations. The program computes and identifies all flows and then calculates pollutant loads for each flow stream.

Runoff and total volume of water to be processed during the current hour are calculated first. Equations 10 and 11 are used. Runoff, dry-weather, and lateral flows are added to determine a total storage requirement. To determine the appropriate withdrawal rate, the program then processes a fairly intricate selection method based on the pumping mode of operation chosen by the user. The result calculated is the volume pumped for the current hour. The pumped volume is also the treated volume.

The original total water volume to be processed in this hour now has both the treated withdrawal volume and the maximum system storage volume subtracted from it. If excess water exists, the remaining volume becomes the overflow volume for that hour. If no excess exists, then pumping and storage are sufficient to contain the volume. When overflows do occur, the code to process the overflow event counter is located in this segment of the program.

The next segment shown in Figure 68 computes the pollutant loads for runoff storage and overflows. The storage, overflow, and treated volumes as calculated in the previous step are used. Equations 12, 13, and 14 are used in this section. The runoff pollutant loads as calculated in Equations 12 and 13 and loads from dry weather and lateral inflows are added together to determine the total load of pollutants to be processed in this hourly time step. The total load and total volume of water are used to calculate the average concentration of pollutants. This information is also used in determining the pollutant load per volume to be multiplied with the overflow volume, as shown in Equation 14.

In the case where the user has specified a removal efficiency in storage, once the overflow pollutant load is calculated the load in storage is readjusted before calculating the treated withdrawal pollutant load.

The last major computation section of EPAMAC calculates the pollutant loads in the treated effluent using either Equation 15 or 16. Equation 16 is used only when the user specifies an effluent concentration rather than a percent removal.

The program now shifts from computation to preparation for printout. Appropriate flow stream pollutant loads and concentrations are assigned to output parameters as guided by user selection. All output data for the hour is then printed. The program has now reached the end of the hourly loop. The logic path returns to the beginning of the hourly loop until the 24 hours of the day have been processed.

At the end of each day, code is processed which writes to the output files and prints the daily information or summary. The output files contain the date and 24 values of flow, BOD load and SS load data for each hour of the day. Once the daily information has been printed, the program reads in the next rain data.

The rain data are read one day at a time. The next data line is read only after the current rain data have been used. The program compares the internal program date with the rain data date and, when they agree, the data is processed. A flag is set to permit the reading of the next data. This section of the program also checks for the end of the input data. When YDATA has the value 999, program control leaves the daily loop and proceeds with the closing write statements and printing of subarea statistics. When YDATA does not have the value 999, the next control block is processed.

The calendar date of the internal program clock is updated in the next segment. Also, the last read rain data are compared to the new clock date for a match. If they are equal, a flag (IGAP) is set to allow use of the rain data in the next day's loop.

The next item is the end of the monthly loop. If the month is not finished, the program goes back and executes the hourly and daily loops for the next day of the month. If the month is complete, the monthly write statements are then processed (providing user selected IPRINT = 2, 3, or 4).

The end of the yearly loop is next, as seen in Figure 68, and at the close of a year the yearly write statements are processed again depending on user choice of IPRINT. The entire set of loops from hourly to yearly will continue to be processed until the 999s in variable YDATA causes the jump to the final printing pass.

The final printing pass writes the monthly, yearly, and subarea write statements. These statements can be identified from the other statements in the output since they contain the phrase PROBABLY INCOMPLETE.

After writing the subarea output line, the statistics for the final mass balance table are calculated. The percentages of flowstream contributions for subarea run totals are calculated. The Mass Balance table is then printed. The last item is return of the subroutine to the MAIN program.

Job Control

Job control statements are a fundamental part of any computer run. Control statements are crucial for access to a program such as EPAMAC stored on the computer system and for identification of input and output files. Job control statements may also specify the compiler to be used in interpreting the program code and other run information.

The format of job control statements is highly variable depending on the brand of computer and the software installed in a computer system. The statements may be located within the program code, as is typical on Digital Equipment Corporation (DEC) computers, or may be a separate set of commands as is typical of International Business Machines (IBM) computers.

The job control statements shown previously in Figures 41 through 43 are for an IBM 370/168 computer. The syntax or format of job control statements for other computers will be different but the basic functions are the same. The remainder of this discussion will focus on the general functions which control statements perform while executing EPAMAC, without giving system specific examples of how to implement the function. The user establishing EPAMAC on a computer system should implement the described functions using appropriate syntax.

The EPAMAC program is used in batch mode. The input data, as described in Section 11, are created in a file and submitted as a computer run. The first function job control statements need to perform is the identification of the EPAMAC program source file or object file that will process the input data. EPAMAC can be kept in source format and compiled before each execution; however, execution will usually be more efficient if an object file is accessed instead. Job control must specify the name of the program file and its location.

Assuming the program is now available to execute the input file, other files to be used in the run must also be identified. Input files can be the rain file or four lateral inflow files. Output files can be the overflow and treated files. A maximum of seven input or output (I/O) files may be required for each subarea to be processed in addition to the original input file for a run. Each I/O file should have name and storage location (disk, tape, etc.) specified for the computer to find it. Space and internal format type of the I/O files may also need to be specified.

The logical unit numbers assigned to each of the I/O files in the job control statements are used in the input data file. The user must be informed of the assigned logical unit number values so the input data can be in agreement with job control statements.

When establishing EPAMAC on a system, be careful to properly open (allow access to) and close files. As an aid to the user, the location of access to the input and output files is shown in Figures 67 and 68. All the I/O files are sequentially read from or written to for each subarea. Pointers should be updated before the first access of the next subarea to be processed. EPAMAC currently has IBM REWIND statements at places appropriate to the computer system being used.

Other functions that job control statements may perform relating to EPAMAC application include transfering files from one storage medium to another, removing files from temporary storage and setting execution time limit. When EPAMAC applications involve extensive rainfall records (say 70 years), the files generated are very large. Disk space is often limited preventing the long term storage of files on disk. Therefore, job control statements may need to first locate files on tape and then transfer the files to disk for temporary storage during the run execution.

At completion of the run, job control can be used to delete unneeded files or transfer new files to tape for storage. The use of such job control functions will vary depending on system size, system capabilities, and user preference.

It is suggested the job control statements be used to establish an execution time limit (if that feature is available). If the input starting month is after the first input data date, the program will search indefinitely for a date match. A time limit will prevent such an event from becoming too costly. A time limit can also be useful to stop a run mistakenly executed with a long period of rainfall rather than the intended short test period file.

File Descriptions

The handling of input and output files has been discussed in general terms in this section. A more detailed description of file type, size, and format is discussed now.

There are three categories of input files comprising six files total per subarea. The first category is one input data file. The second category is one rain input file. The third category is four lateral inflow files.

The input data file is comprised of the 11 (or 12) card groups described in the user instruction section. Each line of the input data must be present, even if blank. All data occur within columns 1-80 (format is fixed block). The total number of lines per subarea is 22 plus one global card per run. The file is small, even if several subareas are run simultaneously.

The input rain file, the second input file category, is actually the 12th card group of the input data file. If the logical unit number of this file is the same as the input file, the rain data are included as part of the input data deck. All data must be within columns 1-80 in the fixed block format shown in Figures 25 and 28. If the unit number is different (i.e., the rain data are in a separate file), then the 132 column (fixed block) format applies shown in Figure 35.

Only days with rain are included in the rain file. No blank lines should exist. It is imperative to have 999 in the last card, columns 10-12. Hours without rain in a day should be marked with a zero. Alternatively, if the computer system automatically assigns blanks as zero, the hours without rainfall can be left blank. The rainfall file is usually much larger than the input data file. As noted in Table 32, the input file is usually 1 track and rainfall files can be up to 60 tracks in length.

The third and final input file category is the lateral inflow files. These files must be generated as EPAMAC output files from base runs. They are written unformatted. The size of these files can be very large; refer to Table 24. The material in the file is the date (year, month, and day) and 24 hourly values each of flow and two pollutant concentrations for every day including days with zero flow or pollutant loads. The file, therefore, has data for every day from the first date of rainfall in the rain file, to the last day of rain processed.

The EPAMAC output files comprise one category. The two files, overflow and treated, have the same characteristics as do the lateral inflow files.

HISTO PROGRAM

Mode of Operation

The use of the HISTO postprocessor program was illustrated previously in Figure 66. This program is most useful during the desk-top review. The run results give a graphic picture of the hourly changes in the flow and pollutant loads. Depending on the input file used, the HISTO results can show the frequency of operation of a wet-weather treatment plant or overflow, the treatment or overflow rate, and the pollutant loads for the plant inflow or outflow or the overflow. The time between operations of the plant can also be determined. This information is particularly useful for determining the time available for cleanup of a wet-weather plant between storms or for developing a definition of an overflow event.

Program Logic Flow Charts

The HISTO program code can be separated into segments reflecting the logic of the program. The relationship of the MAIN program segment and the various subroutines in HISTO is shown in Figure 69. The progression of the logic in the program is shown in Figures 70 through 73.

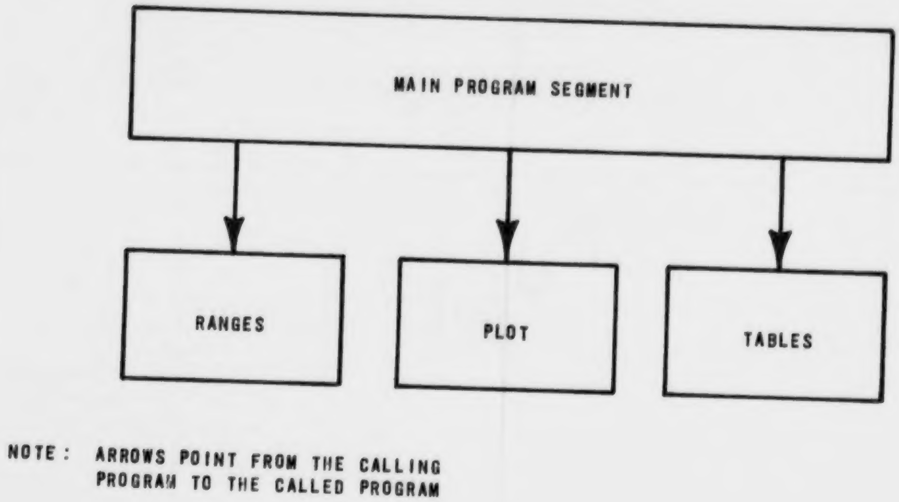

MAIN PROGRAM SEGMENT
RANGES
PLOT
TABLES
NOTE: ARROWS POINT FROM THE CALLING PROGRAM TO THE CALLED PROGRAM

Figure 69. HISTO program.

MAIN Program Segment--

The function of the MAIN program segment is the processing of the input data and performing variable assignments. As shown in Figure 70, the hourly flow, pollutant loads, and pollutant concentrations are developed for the desired simulation time period in the MAIN program segment. The user can specify the form of the output: plots, tables, or both.

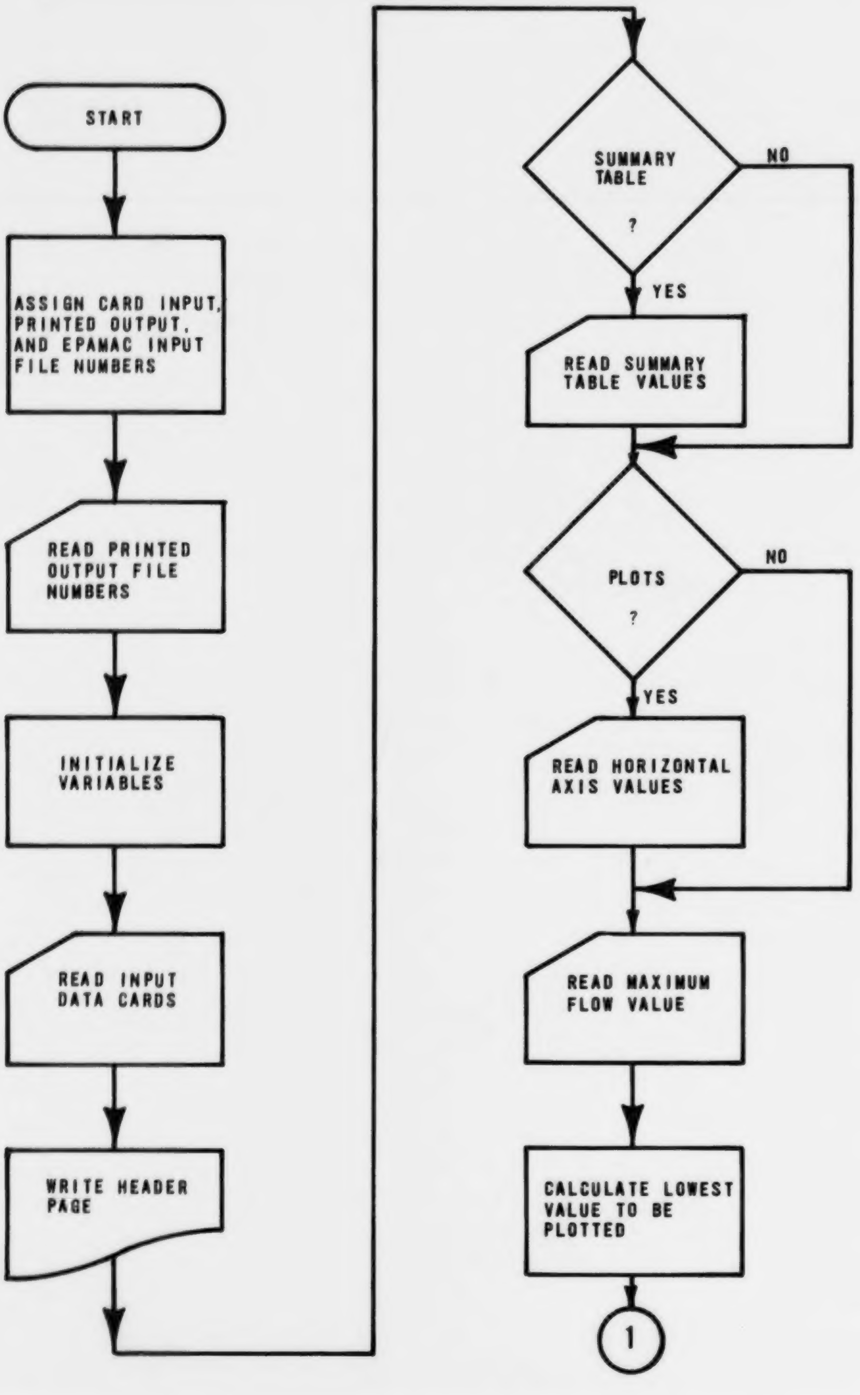

START
ASSIGN CARD INPUT, PRINTED OUTPUT, AND EPAMAC INPUT FILE NUMBERS
READ PRINTED OUTPUT FILE NUMBERS
INITIALIZE VARIABLES
READ INPUT DATA CARDS
WRITE HEADER PAGE
SUMMARY TABLE ?
NO
YES
READ SUMMARY TABLE VALUES
PLOTS ?
NO
YES
READ HORIZONTAL AXIS VALUES
READ MAXIMUM FLOW VALUE
CALCULATE LOWEST VALUE TO BE PLOTTED
1

Figure 70. HISTO main program segment.

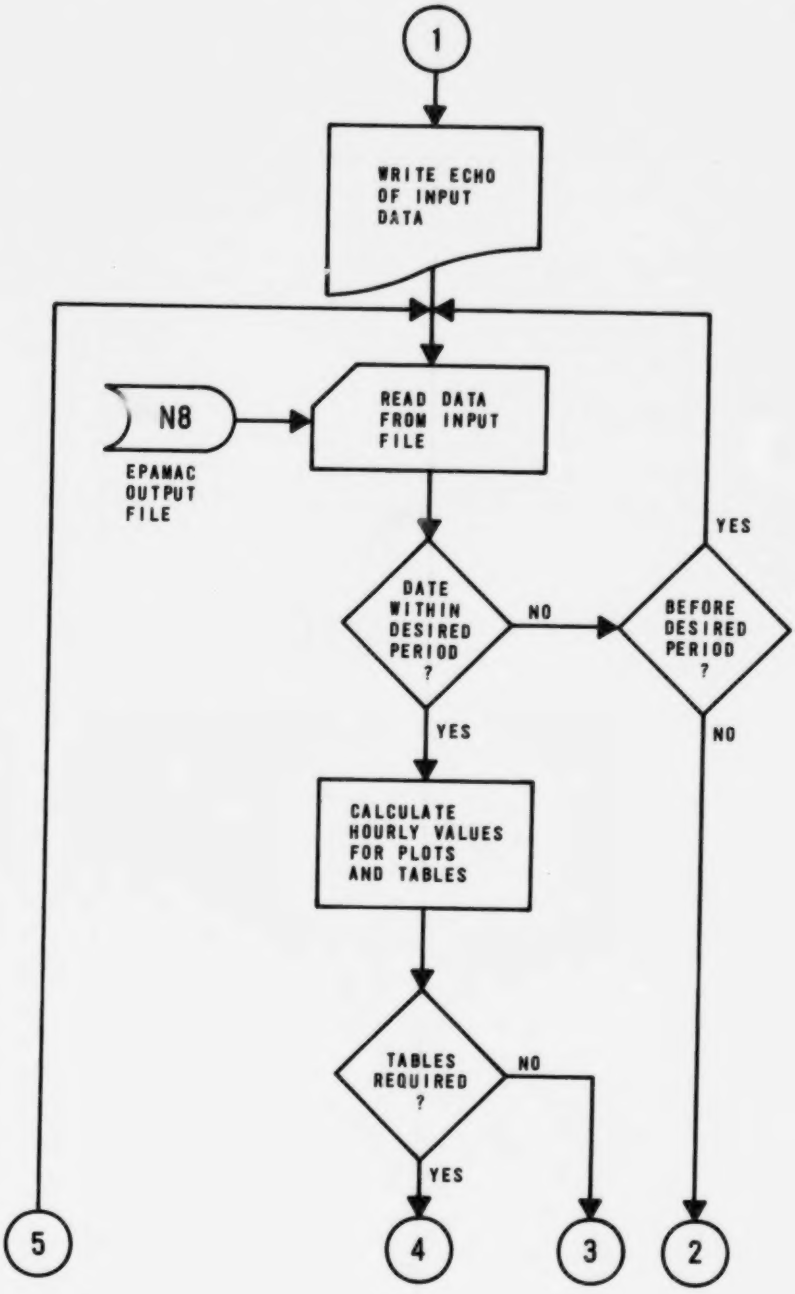


Figure 70 (continued)

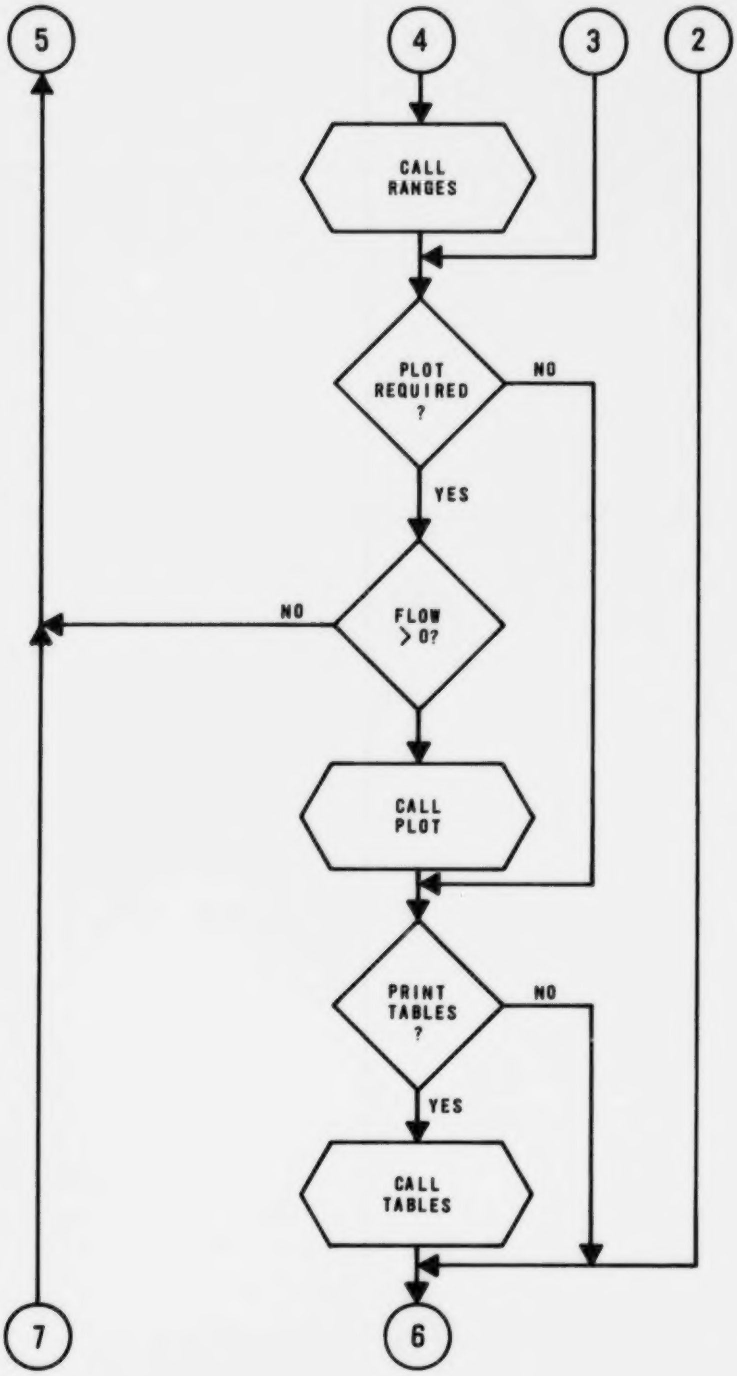


Figure 70 (continued)

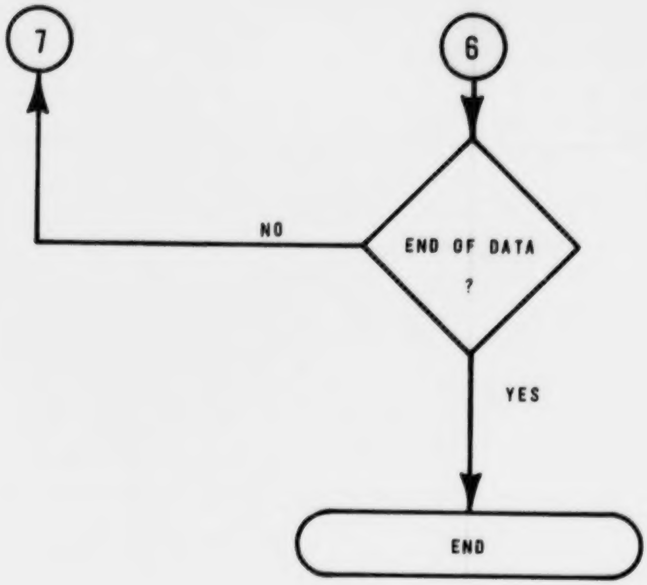


Figure 70 (concluded)

The first function of the MAIN program is to assign input and output file numbers, perform minor preliminary assignments, and declare and dimension variables. All input data cards (Card Groups 1 through 16) are read by this program. A printout header page and an echo of the input data cards are written by the program. An EPAMAC output file is read as input. The dates are checked to determine that they are within the time period of interest, and the hourly values for the plots and tables are calculated. The only calculations performed in this program segment are the conversion of hourly flow volumes to daily flowrates and the conversion of hourly BOD and SS loads to their respective concentrations. If summary tables are desired, subroutines RANGES and TABLES are called. Subroutine PLOT is called if histograms are wanted in the output.

Subroutine RANGES--

The function of subroutine RANGES is to assign hourly flow and BOD and SS concentration and load values to the appropriate range for each summary table desired. A flow chart for subroutine RANGES is shown in Figure 71.

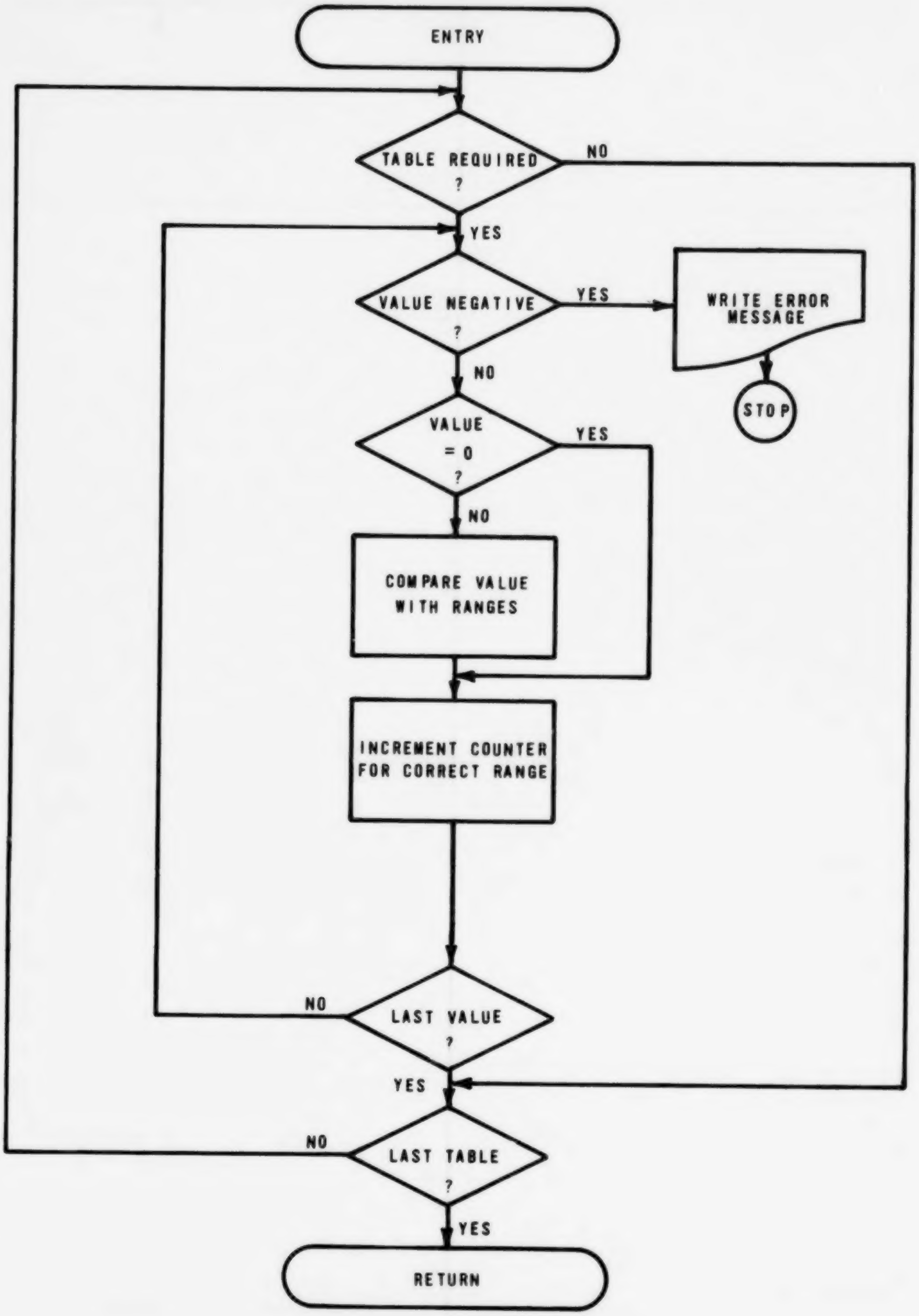


Figure 71. Subroutine RANGES.

Subroutine PLOT--

The function of subroutine PLOT is to print the histograms for flowrate, hourly flow volume, BOD and SS hourly loads, and BOD and SS hourly concentrations. No calculations are performed in this subroutine. Figure 72 illustrates the logic flow chart for subroutine PLOT.

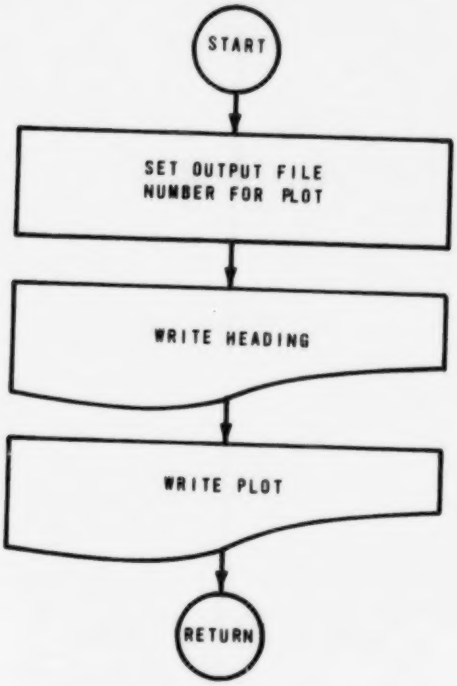


Figure 72. Subroutine PLOT.

Subroutine TABLES--

The function of this subroutine is to print the summary tables that go along with the appropriate histograms. No calculations are performed by this subroutine. The data developed in subroutine RANGES is printed in tabular form by subroutine TABLES. The logic flow chart for subroutine TABLES is shown in Figure 73.

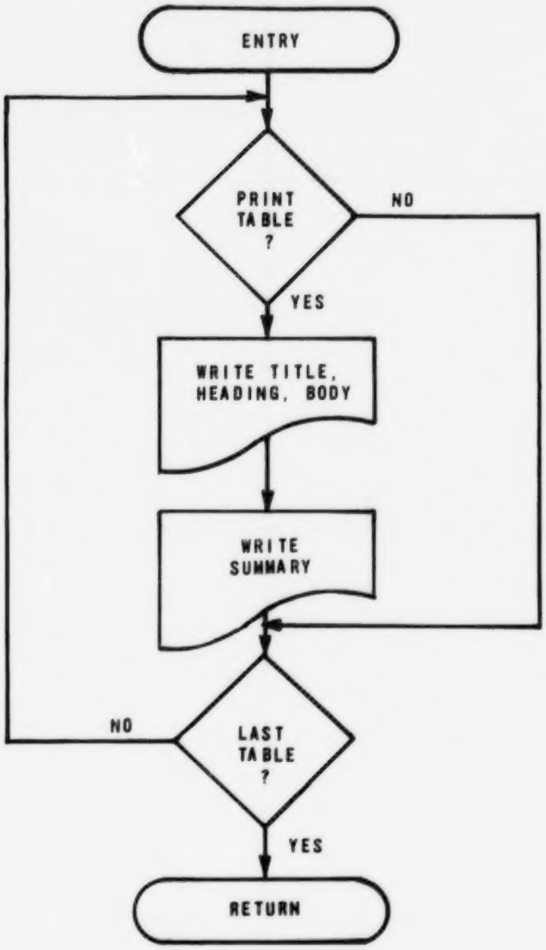


Figure 73. Subroutine TABLES.

VDAY PROGRAM

Mode of Operation

The use of the VDAY postprocessor program was illustrated previously in Figure 66. The VDAY program is most useful during a cost-effectiveness analysis of the reduction in receiving water coliform limitation violation days resulting from various storage/treatment combination alternatives. The program determines the effect on the receiving water coliform concentration of any stormwater or combined sewer overflow.

The program calculates violation day results for three different body contact recreation receiving water coliform concentration limits: (1) events greater than 10,000 MPN/100 mL, (2) 5-day median greater than 240 MPN/100 mL, and (3) 30-day 20-percentile greater than 1,000 MPN/100 mL. It also calculates two different shellfish limits: (1) 30-day median greater than 70 MPN/100 mL, and (2) 30-day 10-percentile greater than 230 MPN/100 mL. In addition, for each limit, the program calculates statistical results for every 5 percentiles for both a normal arithmetic distribution and the actual ranked values.

Program Logic Flow Charts

The VDAY program code can be separated into segments reflecting the logic of the program. The relationship of the MAIN program segment and the various subroutines in VDAY is shown in Figure 74. The progression of the logic in the program is shown in subsequent figures.

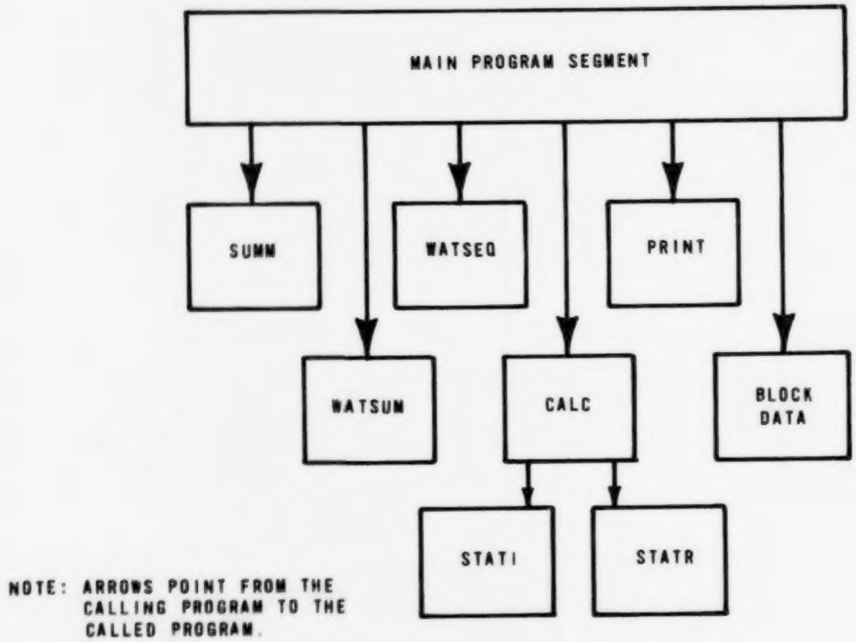

MAIN PROGRAM SEGMENT
SUMM
WATSEQ
PRINT
WATSUM
CALC
BLOCK DATA
STATI
STATR
NOTE: ARROWS POINT FROM THE CALLING PROGRAM TO THE CALLED PROGRAM.

Figure 74. VDAY program.

MAIN Program Segment--

The function of the MAIN program segment is the processing of the input data, calculation of the violation day data, and the writing of the input data summary table. The program logic flow is shown in Figure 75.

The MAIN program segment first reads the input data cards (Card Groups 1 through 4), writes an echo of the data cards, initializes variables, and declares and dimensions variables. Next, the program reads the EPAMAC overflow output file and checks the dates to determine that they are within the time period of interest. Using the hourly overflow data, the violation day data are computed. Initially, the data are in chronological order by calendar year. The data are then reordered by water year (July 1 to June 30) and reordered again by water year in decending order of annual violation days. If desired, summary tables for each of these orderings can be written by calling subroutines SUMM, WATSUM, and WATSEQ, respectively. The statistical variables are then calculated. Subroutine CALC is called to rank the violation day data and calculate the statistics and subroutine PRINT is called to produce the output listing. After the last violation day criteria have been processed, an echo of the input data is printed.

The equations used to calculate the violation day data were discussed previously in Section 12.

Subroutine SUMM--

The function of subroutine SUMM is to write the headings and body of the tabulation of the violation day data in chronological order by calendar year. No calculations are performed in this subroutine. The logic flow chart is shown in Figure 76.

Subroutine WATSUM--

Subroutine WATSUM is used to write the tabulation of the violation day data in chronological order by water year (July 1 to June 30). No calculations are performed in this subroutine. The logic flow chart for subroutine WATSUM is shown in Figure 77.

Subroutine WATSEQ--

A tabulation of violation day data ranked by water year with the greatest to least number of violation days is written by subroutine WATSEQ. Again, no calculations are performed in this subroutine. A logic flow chart for this subroutine is illustrated in Figure 78.

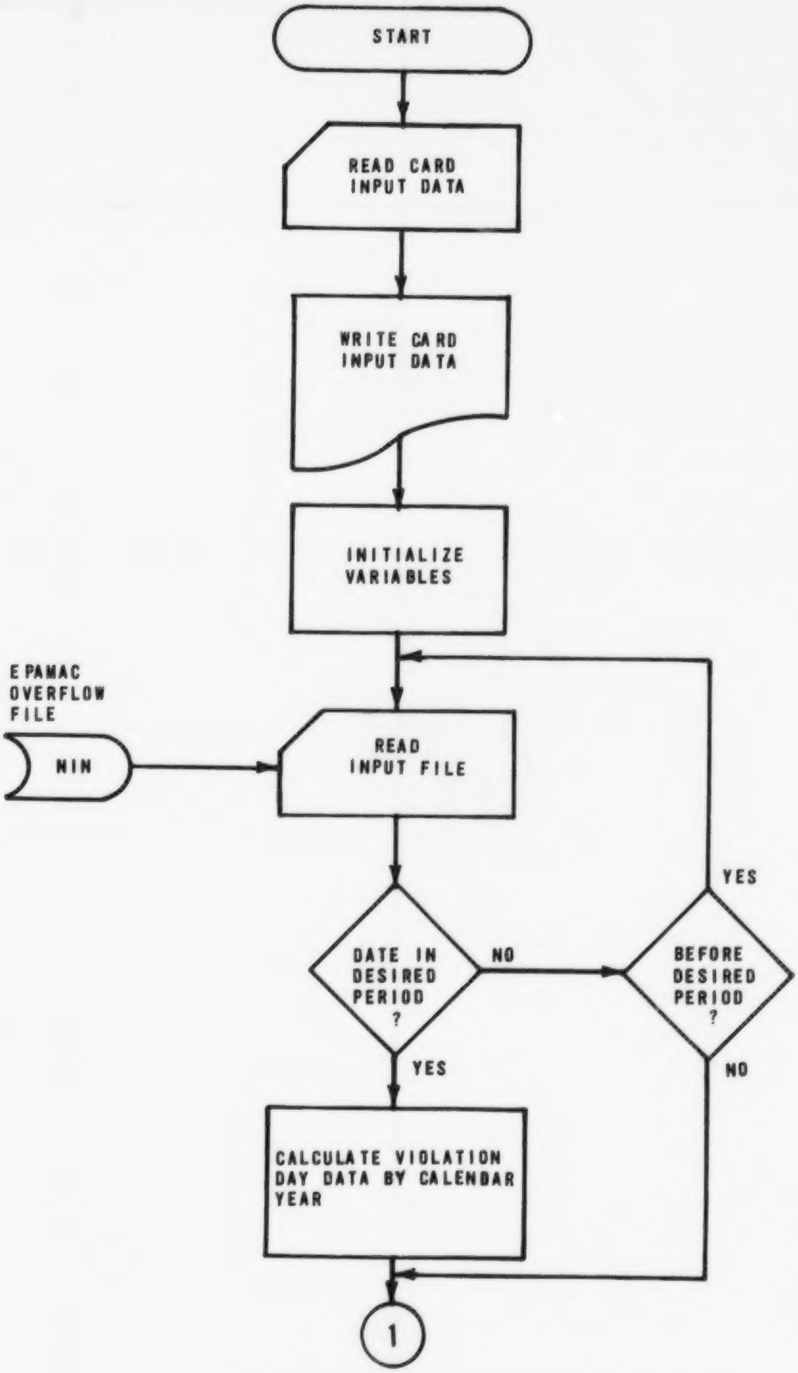


Figure 75. VDAY main program segment.

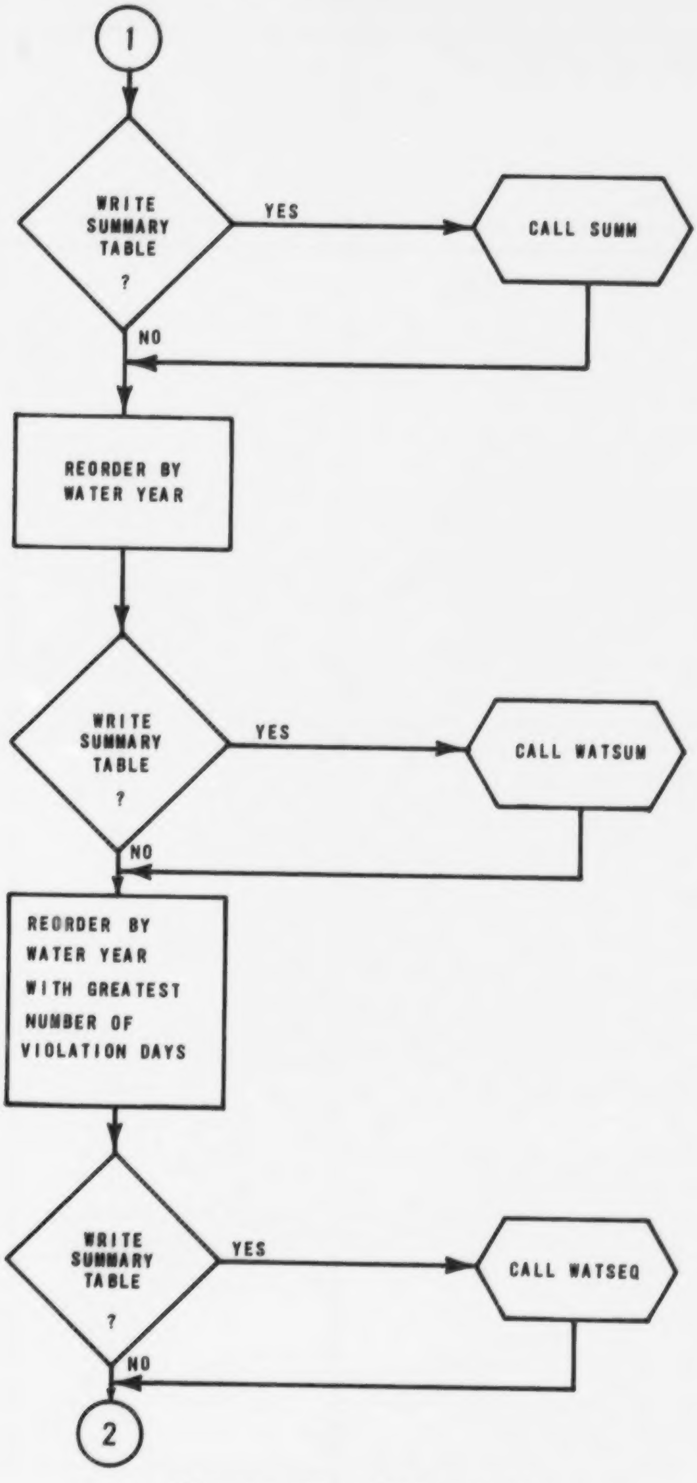


Figure 75 (continued)

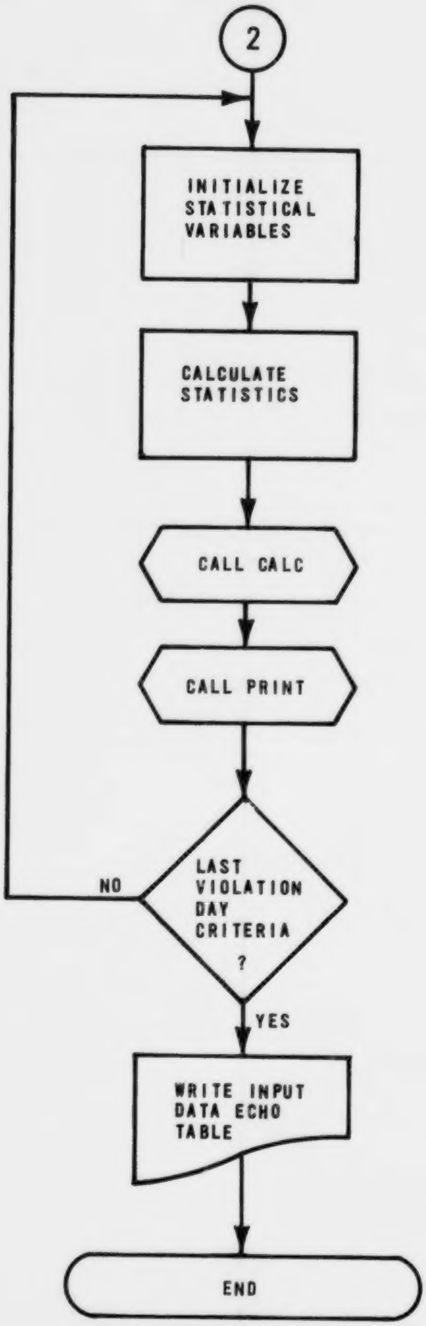

2
INITIALIZE STATISTICAL VARIABLES
CALCULATE STATISTICS
CALL CALC
CALL PRINT
LAST VIOLATION DAY CRITERIA ?
NO
YES
WRITE INPUT DATA ECHO TABLE
END

Figure 75 (concluded)

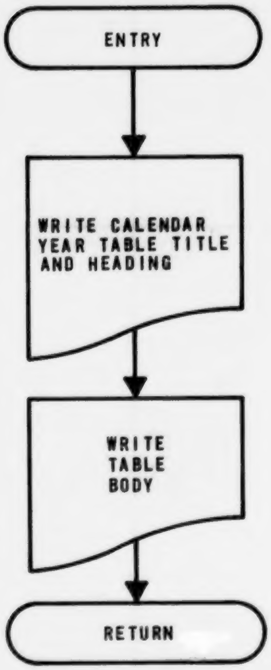


Figure 76. Subroutine SUMM.

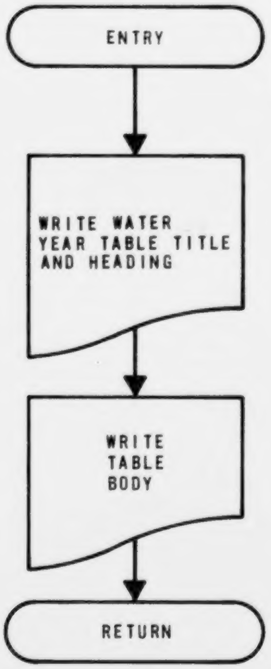


Figure 77. Subroutine WATSUM.

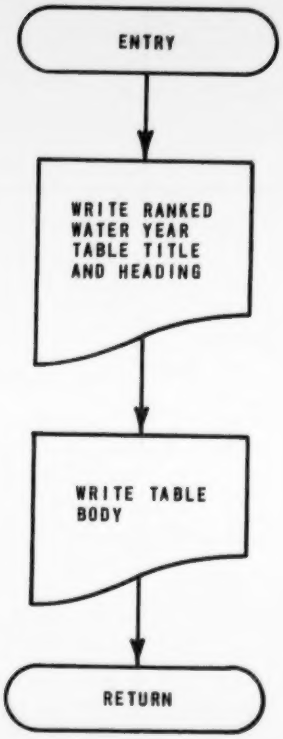


Figure 78. Subroutine WATSEQ.

Subroutine CALC--

The function of subroutine CALC is to rank the various violation day data (i.e., annual overflow hours, overflow events per month, annual violation days, etc.). No calculations are performed by subroutine CALC. Depending on the data being ranked, either subroutine STATI or STATR is called from this subroutine. Figure 79 illustrates the logic flow for subroutine CALC.

Subroutine STATI--

Subroutine STATI calculates the statistical percentile values for integer variables to be printed. The values are based on the actual rankings of the various violation day data. A logic flow chart for this subroutine is shown in Figure 80.

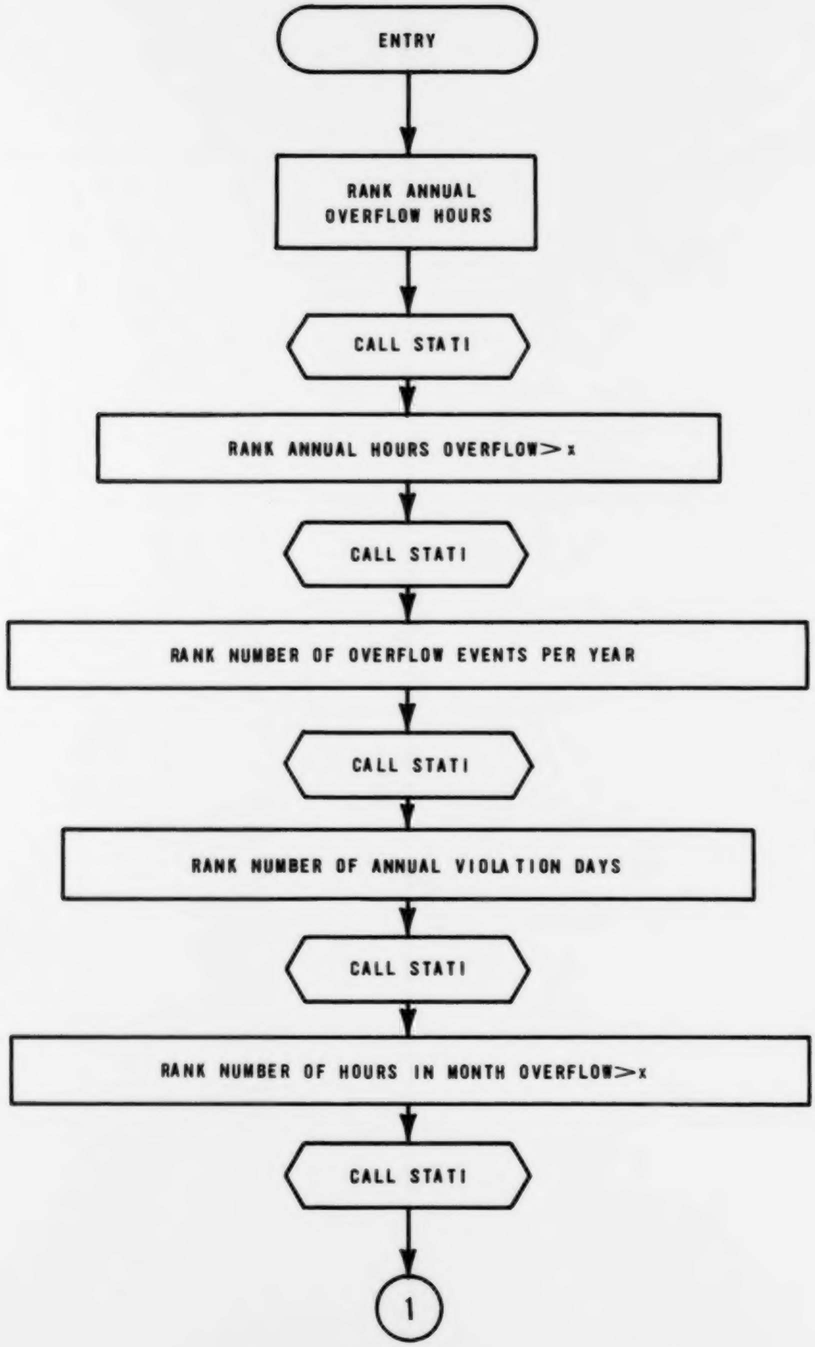

ENTRY
RANK ANNUAL OVERFLOW HOURS
CALL STATI
RANK ANNUAL HOURS OVERFLOW>x
CALL STATI
RANK NUMBER OF OVERFLOW EVENTS PER YEAR
CALL STATI
RANK NUMBER OF ANNUAL VIOLATION DAYS
CALL STATI
RANK NUMBER OF HOURS IN MONTH OVERFLOW>x
CALL STATI
1

Figure 79. Subroutine CALC.

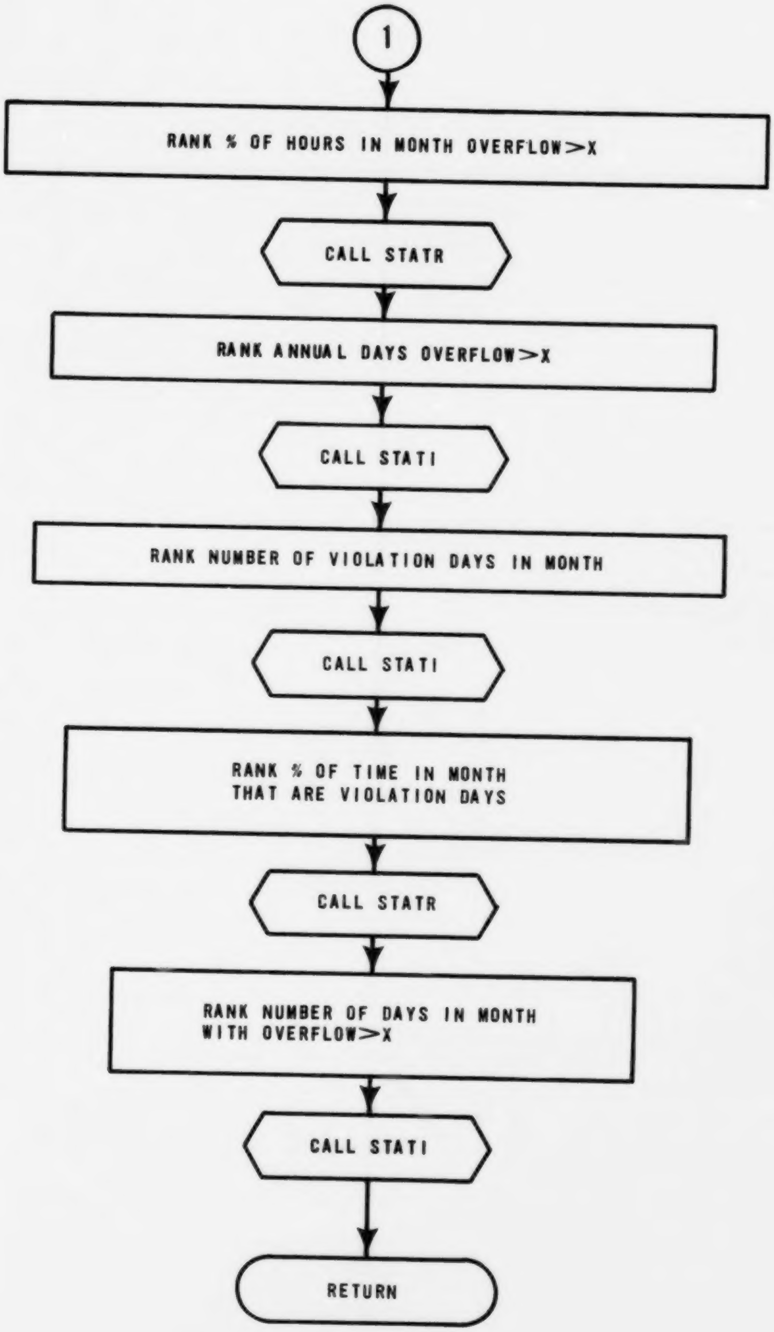

1
RANK % OF HOURS IN MONTH OVERFLOW>X
CALL STATR
RANK ANNUAL DAYS OVERFLOW>X
CALL STATI
RANK NUMBER OF VIOLATION DAYS IN MONTH
CALL STATI
RANK % OF TIME IN MONTH THAT ARE VIOLATION DAYS
CALL STATR
RANK NUMBER OF DAYS IN MONTH WITH OVERFLOW>X
CALL STATI
RETURN

Figure 79 (concluded)

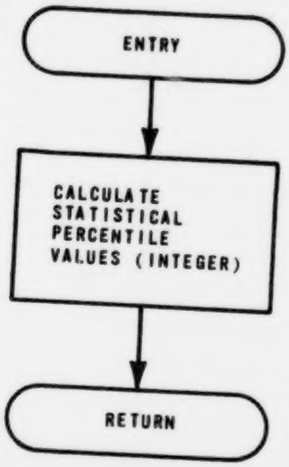


Figure 80. Subroutine STATI.

Subroutine STATR--

Subroutine STATR calculates the statistical percentile values for real variables to be printed in the output. These values are based on the actual rankings of the various violation day data. Figure 81 is a logic flow chart for subroutine STATR.

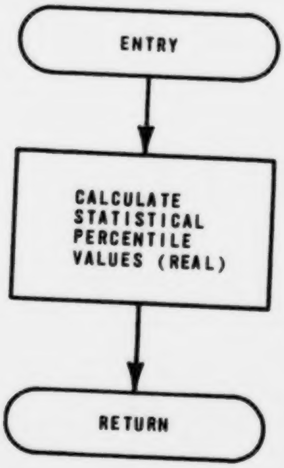


Figure 81. Subroutine STATR.

Subroutine PRINT--

This subroutine performs the printing of the summary table for the violation day data ranked in order by annual violation days and the statistical summary tables. No computation occurs within this subroutine. The logic flow chart for subroutine PRINT is shown in Figure 82.

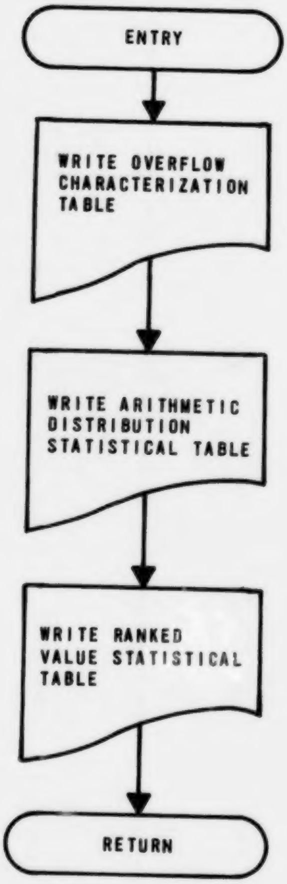

ENTRY
WRITE OVERFLOW CHARACTERIZATION TABLE
WRITE ARITHMETIC DISTRIBUTION STATISTICAL TABLE
WRITE RANKED VALUE STATISTICAL TABLE
RETURN

Figure 82. Subroutine PRINT.

PART IV
REFERENCES, GLOSSARY, ABBREVIATIONS, AND CONVERSION FACTORS

SECTION 14

REFERENCES

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SECTION 15

GLOSSARY

ABMAC--A minicomputer program that was developed by Metcalf & Eddy, Inc. for the Association of Bay Area Governments. This version operates on a daily time step.

Algorithm--A mathematical relationship frequently involving repetition of an operation.

Apparent best alternative--The recommended systemwide wastewater management alternative.

Base run--The first level of MAC runs which calculates stormwater runoff for individual subareas using the rational formula.

Basin Plan--The Water Quality Control Plan for the San Francisco Bay Basin. Plan provides a basis for bay waste discharge requirement established by RWQCB.

Bay--San Francisco Bay.

Bayside--That area of the city which produces dry- and wet-weather sewer flows that drain toward and are currently discharged to the San Francisco Bay.

BOD--Biochemical oxygen demand. The quantity of dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter and oxidizable inorganic matter by aerobic biological action. Generally refers to the standard 5-day BOD test.

City--City and County of San Francisco.

Clean Water Program--The city agency responsible for the development, design, and construction of facilities required to collect, transport, treat, and dispose of municipal wastewater and stormwater runoff.

Combined sewage--Sewage containing both municipal sewage and surface water or stormwater, with or without industrial wastes. Includes flow in heavily infiltrated sanitary sewer systems as well as combined sewer systems.

Combined sewer--A sewer receiving both intercepted surface runoff and municipal sewage.

Combined sewer overflow (CSO)--Flow from a combined sewer in excess of the interceptor capacity that is discharged into a receiving water.

Combining run--The second level of MAC runs which combine lateral inflow data.

Cost/benefit analysis--The study of the costs of installing or constructing a system or works for one or more given purposes compared to the advantages, tangible or intangible, gained by the project.

Data file--A collection of lines of data on a disk or in a card deck.

Detention--The slowing, dampening, or attenuating of flows either entering the sewer system or within the sewer system by temporarily holding the water on a surface area, in a storage basin, or within the sewer itself.

Discharge locus--A point where wastewater from watershed(s) collects for discharge to receiving water.

Domestic wastewater--Wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater.

Dry-weather discharge--The rate of dry-weather flow emerging from a pump, conduit, or channel.

Dry-weather flow--The flow of wastewater in a combined sewer system that does not include stormwater.

Dry-weather treatment--The processing of dry-weather flow. Processing can either be primary treatment only or primary and secondary treatment.

Effluent--Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof.

EPAMAC--A computer program developed by Metcalf & Eddy, Inc. for U.S. EPA. An hourly time step model, this is a generalized and expanded version of SFMAC.

File--Usually on disk, a collection of lines of information.

Final combining run--The second level of MAC runs which combine lateral inflow data and specify system storage and treatment characteristics.

Final run--The third level of MAC runs which typically involves splitting flows or using postprocessor programs for further analysis of data.

First flush--The condition, often occurring in storm sewer discharges and combined sewer overflows, in which a disproportionately high pollutional load is carried in the first portion of the discharge or overflow.

Format--The location and variable type of input parameters that must agree with FORTRAN read and write statements for successful program execution.

Grit--The heavy suspended mineral matter present in water or wastewater, such as sand, gravel, cinders.

HISTO--A postprocessor program analyzing MAC output for printing.

Hydrograph--A graph showing, for a given point on a stream or conduit, the discharge, stage, velocity, available power, or other property of water with respect to time.

ICR--Interim Planning Criteria Report. A report published by Metcalf & Eddy, Inc., February 1978, which documents the first six months of the Southwest Water Pollution Control Plant Project Facilities Planning.

Inflow--The water discharged into a sewer system and service connections from such sources as, but not limited to, roof leaders, cellar, yard, and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catchbasins, stormwaters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

Influent--Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant, or any unit thereof.

Input file--A data file that is used as input for a program.

Input variable--A parameter in the program which the user specifies the value of. It is variable in that each run could have a different value, if desired.

Intercepted surface runoff--That portion of surface runoff that enters a sewer, either storm or combined, directly through catchbasins, inlets, etc.

Interceptor--A sewer that receives dry-weather flow from a number of transverse sewers or outlets and frequently additional predetermined quantities of stormwater (if from a combined system), and conducts such waters to a point for treatment or disposal.

JCL--Job Control Language often used to identify input and output files needed for a program run. Also brings input file together with program for execution.

Loading--Mass of pollutant, usually expressed in pounds per unit of time, of wastewater passing into a waste treatment system or to a body of water.

MAC--The term which refers to the family of MACroscopic planning models--ABMAC, SFMAC, and EPAMAC.

Marine waters--Deep sea or ocean waters.

Master Plan--San Francisco Wastewater Master Plan of 1972 which outlines a system to meet San Francisco's long-range sewage and sewerage facility needs to control water pollution.

Municipal wastewater--Wastewater which may be composed of domestic sewage, industrial wastes, or both.

No project alternative--Describes wastewater master plan that would occur if only existing facilities that collect and treat municipal sewage and stormwater flows, and the additional facilities which are currently under construction were completed.

North Shore--That area of the existing North Point WPCP service area that will continue to drain to the North Shore Pump Station at the North Point WPCP.

NPDES--National Pollutant Discharge Elimination System Permits required by PL 92-500.

Ocean--Pacific Ocean.

Ocean Plan--The State Water Quality Control Plan that provides a basis for waste discharge requirements into the Pacific Ocean.

Output file--A data file that contains output data.

OV--Overflow file.

Overflow--(1) The flow discharging from a sewer resulting from combined sewage, storm wastewater, or extraneous flows and normal flows that exceed the sewer capacity. (2) The location at which such flows leave the sewer.

Overflow file--A MAC output file. Depending on variable specification in a run, the file may or may not represent data from an actual overflow condition.

Overflow frequency--A measure of how often overflows occur during a specific time period. Commonly expressed as average number of events per year.

PL 92-500--The Federal Water Pollution Control Act of 1972 which establishes federal standards and guidelines for the protection of the nation's waterways.

PL 95-217--The Clean Water Act of 1977 which amends PL 92-500 and includes a potential for a waiver of secondary treatment requirements for municipalities discharging into marine (deep ocean) waters.

Pollutant--Any harmful or objectionable material in or change in physical characteristic of water or sewage.

Postprocessor--One of two programs associated with SFMAC and EPAMAC that analyzes MAC output. Programs are VDAY and HISTO.

Primary treatment--The first major (sometimes the only) treatment in a wastewater treatment works, usually sedimentation. It removes a substantial amount of suspended matter but little or no colloidal and dissolved matter.

Rainfile--A data file whose contents are rainfall information.

Rational formula--General method for calculating stormwater runoff. Flow is function of coefficient of permeability of surface area, rainfall intensity and area.

Receiving waters--A natural watercourse, lake, or ocean into which treated or untreated wastewater is discharged.

Regulator--A structure which controls the amount of sewage entering an interceptor by storing in a trunk line or diverting some portion of the flow to an outfall.

Retention--The prevention of runoff from entering the sewer system by storing on a surface area or in a storage basin.

RWQCB--San Francisco Bay Regional Water Quality Control Board.

Run--An execution of a computer program.

Sanitary flow--Domestic wastewater with storm and surface water excluded.

Sanitary sewer--A sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with relatively low quantities of ground, storm, and surface waters that are not admitted intentionally.

Secondary treatment--The treatment of wastewater by biological methods after primary treatment by sedimentation.

SFMAC--San Francisco MACroscopic Planning Model. A computer program developed by Metcalf & Eddy, Inc., to analyze runoff and storage-treatment alternatives for the San Francisco Southwest Water Pollution Control Plant Project Facilities Planning Project. An hourly time step model.

Southeast--That portion of the Bayside area that will be tributary to the expanded Southeast WPCP.

Storage-transport--Underground box sewers that intercept combined sewage flow from small sewers and transport to treatment facilities.

Storm flow--Overland flow, sewer flow, or receiving stream flow caused totally or partially by surface runoff or snowmelt.

Storm sewer--A sewer that carries intercepted surface runoff, street wash and other wash waters, or drainage, but excludes domestic sewage and industrial wastes.

Storm sewer discharge--Flow from a storm sewer that is discharged into a receiving water.

Stormwater runoff--Water resulting from precipitation which runs off freely from the surface, or is captured by storm sewer, combined sewer, and to a limited degree sanitary sewer facilities.

Study area--Portion of the city west of the natural drainage divide in which wastewater flows tributary to the existing Richmond-Sunset WPCP are produced.

Subarea--A discrete unit of area in a watershed. The smallest computational unit of area for a run.

Surface runoff--Precipitation that falls onto the surfaces of roofs, streets, ground, etc., and is not absorbed or retained by that surface, thereby collecting and running off.

TR--Treated file.

TREAT--A computer program developed by the City of San Francisco to analyze runoff and storage-treatment alternatives.

Treated file--A MAC output file. Depending on variable specifications in a run, the file may or may not contain data for a flow stream which is treated.

TSS--Total suspended solids. Solids that either float on the surface of, or are in suspension in, water, wastewater or other liquid and which are removable by laboratory filtering.

Urban runoff--Surface runoff from an urban drainage area that reaches a stream or other body of water or a sewer.

UV--Upper Vicente and Lake Merced area.

VDAY--A postprocessor program analyzing MAC output for violation day data.

Violation day--A day on which the coliform bacteriological concentration in the receiving water exceeds the bacteriological standards established for that receiving water.

Wastewater--The spent water of a community.

Watershed--The area from which surface runoff is carried away by a single drainage system.

Westside--The area of the city which produced dry- and wet-weather sewer flows that drain toward and are discharged to the Pacific Ocean. The Westside area is also referred to as the Richmond-Sunset District.

Wet-weather discharge--The rate of wet-weather flow emerging from an opening, pipe, conduit, or channel.

Wet-weather flow--The flow of wastewater in a combined sewer system that does include stormwater.

Wet-weather treatment--The treatment of wet-weather flows. The treatment processes can be primary treatment only or primary and secondary treatment.

SECTION 16

ABBREVIATIONS

ABAG - Association of Bay Area Governments
ADWF - average dry-weather flow

BOD - biochemical oxygen demand (5-day)
BPI - bits per inch

CCSF - City and County of San Francisco
cm - centimetre

d - Day
DW - dry weather

EPA - U.S. Environmental Protection Agency

FOB - Federal Office Building
ft - foot

h - hour
ha - hectare

ICR - Interim Planning Criteria Report
I/I - infiltration/inflow

JCL - job control language
Jtu - Jackson turbidity unit

klb - kilopound (1,000 lb)

L - litre

max - maximum
mg - milligram
Mgal - million gallons
MPN - most probably number

NPDES - National Pollutant Discharge Elimination System
NS - North Shore
NWS - National Weather Service

pci - picocuries

ppb - parts per billion
ppm - parts per million
PWWF - peak wet-weather flow

RS - Richmond-Sunset
RT - Richmond Transport
RWQCB - Regional Water Quality Control Board

s - second
SE - Southeast WPCP
SS - suspended solids
SSWMM - Simplified Storm Water Management Model
SW - Southwest WPCP

TICH - total identifiable chlorinated hydrocarbons
TSS - total suspended solids
tu - toxicity units

WPCP - Water Pollution Control Plant
WST - Westside Transport
WW - wet weather

yr - year

> - greater than
< - less than

SECTION 17

CONVERSION FACTORS
U.S. Customary to SI (Metric)

U.S. customary unit			SI	
Name	**Abbreviation**	**Multiplier**	**Symbol**	**Name**
acre	acre	0.405	ha	hectare
acre-inch	acre-in.	1,233.5	m^3	cubic metre
cubic foot	ft^3	28.32 0.0283	L m^3	litre cubic metre
degrees Fahrenheit	°F	0.555(°F-32)	°C	degrees Celsius
feet per second	ft/s	0.305	m/s	metres per second
foot (feet)	ft	0.305	m	metre(s)
gallon(s)	gal	3.785	L	litre(s)
gallons per capita per day	gal/capita·d	3.785	L/capita·d	litres per capita per day
inch(es)	in.	2.54	cm	centimetre(s)
inches per hour	in./h	2.54	cm/h	centimetres per hour
million gallons	Mgal	3.785 3,785.0	ML m^3	megalitres cubic metres
million gallons per day	Mgal/d	0.0438	m^3/s	cubic metres per second
pound(s)	lb	0.454	kg	kilogram(s)
pounds per cubic foot	lb/ft^3	16.018	kg/m^3	kilograms per cubic metre
pounds per square foot per second	$lb/ft^2 \cdot s$	47.8803	$N/m^2 \cdot s$	newtons per square metre per second
square foot	ft^2	0.0929	m^2	square metre
square inch	$in.^2$	6.452	cm^2	square centimetre

Appendix A

PROGRAM AND VARIABLES LISTING

As an aid to the user, a complete listing of the three computer programs (EPAMAC, HISTO, and VDAY) is included in this Appendix. Each program line has an alphanumeric identifier in columns 73 through 80. A four letter alphameric designation for either the main program or a subroutine name is in columns 73 through 76. Columns 77 through 80 include the sequence number within the subroutine or main program.

Listings of the variables used in each of the three programs are presented also. These lists include the variable name, index information, description, and default values. The index information identifies the variables used as input, output (either printout or file), and in shared common blocks.

The following tables are included in this appendix:

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A-3	EPAMAC Hourly Subroutine Variables List	242
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Table A-1. EPAMAC PROGRAM LISTING

```
C      **********************************************
C        MAC MODEL      VERSION=EPAMAC1      08/15/80
C
C                    EPA  APPLICATION
C
C      **********************************************
C      DEVELOPER: JOHN FINNEMORE
C                 METCALF & EDDY, INC., ENGINEERS
C                 P.O. BOX 10-046
C                 1029 CORPORATION WAY
C                 PALO ALTO, CALIF. 94303
C                    TEL:  415/964-7100
C      **********************************************
C
C      THIS COMPUTER PROGRAM WAS DEVELOPED BY METCALF & EDDY, INC.,
C      AND REFINED IN CONNECTION WITH THE SAN FRANCISCO SOUTHWEST
C      WPCP PROJECT, DPW ORDER NO.  108.332.  THIS MODEL WAS THEN
C      GENERALIZED AND DOCUMENTED FOR THE U.S. ENVIRONMENTAL
C      PROTECTION AGENCY IN CONNECTION WITH THE DEVELOPMENT OF
C      PLANNING AND DESIGN PRINCIPLES FOR URBAN STORM WATER
C      AND COMBINED SEWER OVERFLOWS TREATMENT CONTROL FACILITIES,
C      CONTRACT NO. 68-03-2877.
C                 ---- AUGUST  15, 1980 ----
C
C      **********************************************
C
      DIMENSION  AUSE(6,5),MODES(2),AREA(6),WPUMP(5),CLIENT(6),
     *           FREQS(2,5),IHR(12),ROK(6),DWFBC(24),DWFSC(24)
      COMMON  STMAX,STCRIT,COEFX,BCONC(3),SCONC(3),MRODRY,RAINMN,
     *     RFAC,WNAME(5),WASHED(5),MOVSEP,MSTDRY,MODE,FREQ(2),IPRINT,
     *     N1,N2,N3,N4,N5,N6,N7,N8,N9,IQUAL(3),IQL1,IQL2,IQL3,NTRAV(4),
     *     ITREAT,REMTRB,REMTRS,TRBC,TRSC,MWTYR,REMSTB,REMSTS,
     *     PUMP(7),VOLON(5),VOLOFF(5),DWF(24),DWFB(24),DWFS(24)
      COMMON  /QOPTS/  QOPT(2,4)
      DATA FREQS/' YEA','RLY ',
     *           'MONT','HLY ',
     *           '  DA','ILY ',
     *           ' HOU','RLY ',
     *           'SUBA','REA '/
      DATA MODES/'MINI','MAXI'/
C
C
C     ASSIGN READ AND WRITE UNIT NUMBERS.
C     N8 IS THE CARD READER OR INPUT FILE LOGICAL UNIT NUMBER
C     N9 IS THE LINE PRINTER
C     NOTE:  ALL ACCESSES TO FILE OTHER THAN UNIT N8 ARE COMMENTED
C            WITH A @.  BE SURE TO OPEN OR DECLARE RAINFILE, AND
C            OUTPUT FILES IN THE MAIN SEGMENT OR REMOVE THE REWIND
C            STATEMENTS AND THEN OPEN THEM IN THE HOURLY SUBROUTINE
C
C     NOTE:  THIS PROGRAM CONTAINS STOP STATEMENTS.  IF THE COMPILER ON
C            ANOTHER SYSTEM DOES NOT ALLOW STOP STATEMENTS REPLACE THEM
C            WITH GO TO 90909 STATEMENT IN THE MAIN PROGRAM AND
C            SUBROUTINE HOURLY
C
C
       N8 = 5
       N9 = 6
C
C***** BEGIN INITIAL READ SECTION OF PROGRAM WITH VARIABLE
```

Table A-1 (Continued)

```
C        ASSIGNMENTS AND CALCULATIONS INTERSPERSED.
C
C        CARD GROUP NO. 1
C            READ NO. OF SUBAREAS, MONTHLY AND/OR DAILY PRINTING OPTION,
C            GLOBAL RAINFILE INPUT FILE NO., AND WATER YEAR STARTING
C            MONTH (EXAMPLE , A 7 FOR JULY)
C
      READ(N8,50)NSUBS,IPRINT,(CLIENT(I),I=1,6),NIN,MWTYR
   50 FORMAT(I2,I4,4X,6A4,2I6)
C
      IF (IPRINT .EQ. 0) IPRINT=5
C
C
C           WRITE GLOBAL INFORMATION ON INITIAL PAGE
C
      WRITE(N9,79) (CLIENT(I),I=1,6)
   79 FORMAT(1H1,5X,45HEPAMAC1 (08/15/80 VERSION) SIMULATION STARTED,
     *//////////,T26,6A4,T81,16HMETCALF & EDDY, ,
     *15HINC., ENGINEERS,/,
C
     *T81,23HPALO ALTO, CALIF.       ,////)
      WRITE(N9,791)
 791  FORMAT(1H ,5X,'THIS COMPUTER PROGRAM WAS DEVELOPED BY METCALF &',
     *' EDDY, INC., AND REFINED IN CONNECTION WITH THE SAN FRANCISCO ',
     *'SOUTHWEST',/,6X,'WPCP PROJECT, DPW ORDER NO. 108,332.  THIS ',
     *'MODEL WAS THEN ','GENERALIZED AND DOCUMENTED FOR THE ',
     *'U.S. ENVIRONMENTAL',/,6X,'PROTECTION AGENCY IN CONNECTION ',
     *'WITH THE DEVELOPMENT',' OF PLANNING AND DESIGN PRINCIPLES ',
     *'FOR URBAN STORM WATER AND ',/,6X,'COMBINED SEWER OVERFLOWS ',
     *'TREATMENT',' CONTROL FACILITIES, CONTRACT NO. 68-03-2877.',
     */,51X,'----   AUGUST 15, 1980  ----')
C
C
C           ASSIGN PRINT FREQUENCY TITLE APPROPRIATE VALUE
      DO 120  I=1,2
  120   FREQ(I) = FREQS(I,IPRINT)
C
C           WRITE NO. OF SUBAREAS, MONTHLY AND/OR DAILY PRINTING OPTION,
C           INPUT FILE NO.
C
      WRITE(N9,60) NSUBS,FREQ,NIN
   60 FORMAT(1H0,//////,1H ,132('-'),//,T45,'INITIAL INPUT DATA',
     *' (GOVERNING ALL SUBAREAS)',/,T45,43('-'),////,
     *T34,'NO. OF SUBAREAS',T64,'=',T67,I2,///,T34,
     *'PRINTING OPTION IN EFFECT',T64,'=',T67,2A4,
     *///,T34,'RAINFALL INPUT FILE NO.',T64,'=',T67,I2,
     *5X,'(WHEN NOT OVERRIDDEN BY A NONZERO VALUE OF N5 BELOW)',
     *///,1H ,132('-'),////)
      IF (NIN) 142,144,146
C
C          WRITE ERROR MESSAGE
C
  142   WRITE(N9,61) NIN
   61  FORMAT(1H1,'COMPUTATION STOPPED. INPUT FILE IS NEGATIVE',I4,'.')
        STOP
C
C          IF GLOBAL RAINFILE UNIT NO. IS ZERO, ASSIGN VALUE OF UNIT N8
C
  144   NINP = N8
        GO TO 1111
```

Table A-1 (Continued)

```
  146   NINP = NIN
C
C       REPEAT ENTIRE PROGRAM BELOW FOR EACH OF THE 'NSUBS' SUBAREAS
C***** BEGINNING OF SUBAREA LOOP
C
C
 1111 DO 99999 NSUB=1,NSUBS
C
C       CARD GROUP NO. 2
C           READ WATERSHED NAME, STORAGE OPERATIONAL MODE,
C           WATERSHED ALTERNATE NAME
C
      READ(N8,51)  WASHED,MODE,WNAME
   51 FORMAT(2X,5A4,17X,I1,20X,5A4)
C
C       CARD GROUP NO. 3
C           READ LAND USE; RUNOFF COEFFICIENT; AREA (IN ACRES), FOR EACH
C           OF SIX LAND USES
C
      DO 200  I=1,6
  200 READ(N8,52)  (AUSE(I,K),K=1,5),ROK(I),AREA(I)
   52 FORMAT(2X,5A4,2X,2F8.2)
C
C       CARD GROUP NO. 4
C           READ: 3 QUALITY PRINT OPTIONS, HOURLY CONCENTRATIONS (MG/L)
C                 OF BOD & SS IN RUNOFF
C
      READ(N8,58)  IQUAL,RAINMN,BCONC,SCONC
   58 FORMAT(2X,3I2,8X,F8.3,6F8.2)
        IQL1P = IQUAL(1)
        IQL2P = IQUAL(2)
        IQL3P = IQUAL(3)
      DO 250  I=1,3
  250 IF (IQUAL(I) .EQ. 0)  IQUAL(I) = 4
        IQL1 = IQUAL(1)
        IQL2 = IQUAL(2)
        IQL3 = IQUAL(3)
C
C       CARD GROUP NO. 5
C           READ:  7 I/O UNIT NUMBERS, GROSS RUNOFF COEF.  (OVERRIDE) ,
C           MAX & 'CRIT' STORAGE VOLUMES IN MIL. GAL.,
C           RAINFALL MULTIPLIER, MIN. DRY HRS. FOR TYPE C OVERFLOW EVENT
C           DEFINITION, MIN. DRY HRS. FOR RUNOFF EVENT DEFINITION AND
C           MIN. DRY HRS. TO TRIGGER MODE1.
C
      READ(N8,53)  N1,N2,N3,N4,N5,N6,N7,AKOVER,STMAX,STCRIT,RFAC,MOVSEP,
     *MRODRY,MSTDRY
   53 FORMAT(2X,7I2,8X,4F8.2,4X,3(2X,I2))
      IF (N5 .NE. 0)  GO TO 300
C           ASSIGN GLOBAL VALUE TO RAIN FILE UNIT NO. IF N5 IS ZERO.
        N5 = NINP
C
C          READ FROM UNIT, N5 SPECIFIED FOR THIS SUBAREA
C
C  a      IF RAINFILE IS SEPARATE FROM INPUT DATA UPDATE POINTER
C              NOTE:  IF DESIRED REMOVE THIS LINE OF CODE AND PLACE
C                     AT BEGINNING OF SUBROUTINE HOURLY.
C
  300 IF (N5 .NE. N8)  REWIND N5
C
```

Table A-1 (Continued)

```
C      CARD GROUP NO. 6
C          READ:  STORAGE VOLUME SWITCHES (MGAL),STAGED
C          WITHDRAWAL RATES (MGD).
C
      DO 310  II=1,5
        I = 6 - II
  310 READ(N8,56)  VOLON(I),VOLOFF(I),WPUMP(I)
   56 FORMAT(32X,3F8.2)
C
C      CARD GROUP NO. 7
C          READ:  TRAVEL TIME DELAYS (HRS.), AND DWF TREATMENT
C          CAPACITY (MGD)
C
      READ(N8,55)  NTRAV,DWTRT
   55 FORMAT(2X,4I2,38X,F8.2)
C
C      CARD GROUP NO. 8
C          READ:  TREATMENT OPTION, BOD & SS REMOVAL EFFICIENCIES (%),
C                 BOD & SS CONCENTRATIONS IN EFFLUENT (MG/L), AND
C                 BOD & SS STORAGE REMOVAL EFFICIENCIES (%)
C
C
      READ(N8,54)  ITREAT,REMTRB,REMTRS,TRBC,TRSC,REMSTB,REMSTS
   54 FORMAT(3X,I1,20X,6F8.2)
C
C          WRITE WATERSHED NAME, SUBAREA NAME, HEADINGS
C
      WRITE(N9,63)  NSUB,WASHED,WNAME
   63 FORMAT(1H1,132('-'),//,T34,'SUBAREA NUMBER',I3,':     ',5A4,4X,
     *5A4,/,T34,66('-'),
     *//,1H ,'LAND USE CHARACTERISTICS:',/,1H+,25('_'),//,T43,
     148('-'),/,70X,'AREA',/,52X,'LAND USE',10X,'ACRES   K-FACTOR',/,
     246X,20('-'),3X,'-------',2X,8('-'),/ )
C
C          COMPUTE EFFECTIVE OVERALL RUNOFF COEFFICIENT
C          AREA WEIGHT THE RUNOFF COEFFICIENT
C
  320   SAXRO = 0.0
        SARE  = 0.0
      DO 340  I=1,6
        SARE = SARE + AREA(I)
  340   SAXRO = SAXRO + AREA(I)*ROK(I)
        COEFX = SAXRO*0.027156
        COEFO = 0.0
      IF (SARE .NE. 0.0)  COEFO = SAXRO/SARE
C
C          TEST FOR RUNOFF COEFFICIENT OVERRIDE
C         IF AKOVER .GT. ZERO, AKOVER IS USED INSTEAD OF THE CALCULATED
C         RUNOFF COEFFICIENT
C
      IF (AKOVER .GT. 0.0)  COEFX = AKOVER*SARE*0.027156
        COEFY = 0.0
      IF (SARE .NE. 0.0)  COEFY = COEFX/(0.027156*SARE)
C
C          WRITE LAND USE; AREA; RUNOFF FACTOR; - FOR EACH LAND USE
C
      DO 350  I=1,6
  350 WRITE(N9,65)  (AUSE(I,K),K=1,5),AREA(I),ROK(I)
   65 FORMAT(46X,5A4,2X,F8.0,F8.2)
      WRITE(N9,73)  SARE,COEFO,AKOVER,COEFY
```

Table A-1 (Continued)

```
   73 FORMAT(1H0,45X,20('-'),3X,7('-'),2X,8('-'),
     *     /,1H0,45X,'TOTAL',17X,F8.0,
     *     /,1H ,45X,'WEIGHTED AVERAGE',14X,F8.2,
     *     /,1H ,45X,'OVERRIDE',22X,F8.2,
     *     /,1H ,45X,'GOVERNING',21X,F8.2,//,42X,48('-'))
C
C          WRITE MAX STORAGE VOLUME, PUMP STAGE ON & OFF VOLUME SWITCH
C          AND STAGED CAPACITIES OF:  WET WEATHER PUMPS, DRY WEATHER
C          PUMPS AND RESULTING TOTAL WITHDRAWAL RATES
C
  475 WRITE(N9,68)
   68 FORMAT(////,1H ,'STORAGE AND PUMP CAPACITIES:',/,1H+,28('_'),
     *          //,34X,63('-'),/,35X,'S T O R A G E  (MGAL)',
     *            15X,'PUMP CAPACITIES (MGAL/D)',
     *          /,34X,24('-'),3X,'PUMP',4X,28('-'),
     *          /,34X,'MAXIMUM   PUMP  CONTROLS',13X,'WET',6X,'DRY',
     *          6X,'TOTAL',/,34X,'STORAGE',3X,14('-'),3X,'STAGE',3X,
     *            2('WEATHER  '),'WITHDRAWAL',
     *          /,34X,'CAPACITY',4X,'ON',6X,'OFF',33X,'RATE',
     *          /,34X,8('-'),2('  ------'),3X,5('-'),3X,
     *            2('-------  '),10('-'),/)
C
      DO 485  I=3,7
  485   PUMP(I) = WPUMP(I-2) + DWTRT
        PUMP(2) = DWTRT
        PUMP(1) = 0.0
      WRITE(N9,69)  STMAX,VOLON(5),VOLOFF(5),WPUMP(5),DWTRT,PUMP(7)
   69 FORMAT(34X,F7.1,2F8.1,6X,'6',F11.1,F9.1,F11.2)
      DO 490  II=1,4
        I = 5 - II
        I1 = I + 1
  490 WRITE(N9,70)  VOLON(I),VOLOFF(I),I1,WPUMP(I),DWTRT,PUMP(I+2)
   70 FORMAT(1H ,40X,2F8.1,I7,F11.1,F9.1,F11.2)
      WRITE(N9,86)  DWTRT,PUMP(2)
   86 FORMAT(1H ,62X,'1',8X,'0.0',F9.1,F11.2,//,34X,63('-'))
C
C          STORAGE/WITHDRAWAL CHECKS
C          EACH VALUE OF VOLOFF CAN NOT BE GREATER THAN THE ASSOCIATED
C          VALUE OF VOLON, PUMP VALUES SHOULD BE THE SUMMATION OF ALL
C          PUMPING CAPACITY AVAILABLE AT THAT STAGE(IE. INCREASING
C          VALUES), ALSO VOLON SHOULD CONTAIN INCREASING VALUES
C
C
      IF (STMAX    .LT. VOLON(5) .OR  'OLON(5) .LT. VOLON(4) .OR.
     *    VOLON(4) .LT. VOLON(3) .OR  'OLON(3) .LT. VOLON(2) .OR.
     *    VOLON(2) .LT. VOLON(1) .OR. VOLON(1) .LT. 0.0)  GO TO 491
      IF (VOLOFF(5) .GT. VOLON(5) .OR. VOLOFF(4) .GT. VOLON(4) .OR.
     *    VOLOFF(3) .GT. VOLON(3) .OR. VOLOFF(2) .GT. VOLON(2) .OR.
     *    VOLOFF(1) .GT. VOLON(1))  GO TO 491
      IF (MSTDRY .LT. 0 .OR. STCRIT .GT. STMAX .OR.
     *    STCRIT .LT. 0.0)  GO TO 491
      IF (PUMP(7) .LT. PUMP(6) .OR.
     *    PUMP(6) .LT. PUMP(5) .OR. PUMP(5) .LT. PUMP(4) .OR.
     *    PUMP(4) .LT. PUMP(3) .OR. PUMP(3) .LT. PUMP(2) .OR.
     *    PUMP(2) .LT. PUMP(1) .OR. PUMP(1) .LT. 0.0)  GO TO 491
      GO TO 492
C
C        WRITE ERROR MESSAGE
C
  491 WRITE(N9,72)
```

```
   72 FORMAT(1H0,//,1X,'INCONSISTENCIES IN STORAGE VOLUMES AND/OR ',
     *       'WITHDRAWAL RATES')
      STOP
C
C         WRITE:  RAINFALL FACTOR, RUNOFF QUALITY PER STORM HOUR,
C                 DRY PERIOD FOR RUNOFF EVENT DEFINITION, AND
C                 MINIMUM RAINFALL TO RESET POLLUTANT QUALITY
C
C
  492 IF (MRODRY .LE. 0) MRODRY = 1
      WRITE(N9,83)  RFAC,BCONC,SCONC,MRODRY,RAINMN
   83 FORMAT(1H1,/,1X,'WET WEATHER FLOW:',/,1H+,17('_'),
     *          //,54X,'RAINFALL FACTOR =',F5.2,//,43X,45('-'),
     *        /,45X,'POLLUTANT CONCENTRATION IN SURFACE RUNOFF',
     *        /,43X,45('-'),//,43X,'HOUR:',12X,'1',7X,'2',6X,'3+',
     *       //,48X,'BOD (MG/L)',3F8.2,
     *        /,48X,'SS  (MG/L)',3F8.2,//,43X,45('-'),
     *       //,45X,'DRY PERIOD FOR RUNOFF EVENT DEFINITION = ',I2,
     *       //,45X,'MINIMUM RAINFALL TO RESET POLLUTANT',
     *        /,45X,'CONCENTRATIONS IN SURFACE RUNOFF = ',F8.3,/)
C
C         READ  HOURLY DRY WEATHER VARIATION, AS FOLLOWS:
C
C              CARD GROUP NO. 9
C                  24 FLOW VALUES (MGAL/HR)
C
C              CARD GROUP NO. 10
C                  24 BOD VALUES (KLB/HR)
C
C              CARD GROUP NO. 11
C                  24 SS VALUES (KLB/HR)
C
C
      READ(N8,57)  DWF,DWFB,DWFS
   57 FORMAT(12F6.3)
      DO 493  J=1,12
  493   IHR(J) = J
      DO 495  J=1,24
      IF (DWF(J) .EQ. 0.0)  GO TO 494
        DWFBC(J) = (DWFB(J)/DWF(J))*(1000.0/8.345)
        DWFSC(J) = (DWFS(J)/DWF(J))*(1000.0/8.345)
      GO TO 495
  494   DWFBC(J) = 0.0
        DWFSC(J) = 0.0
  495 CONTINUE
C
C         WRITE DRY WEATHER FLOW, LOAD AND CONCENTRATION DATA
C
      WRITE(N9,67)  IHR,DWF,DWFB,DWFS,DWFBC,DWFSC
   67 FORMAT(///,1H ,'DRY WEATHER FLOW:',
     *          /,1H+,17('_'),//,1H ,4X,127('-'),
     *         //,1H ,4X,'HOUR',15X,12I9,
     *         //,1H ,4X,'AM DWF (MGAL/H) ',3X,12F9.2,
     *          /,1H ,4X,'PM DWF (MGAL/H) ',3X,12F9.2,
     *         //,1H ,4X,'AM DWF BOD (KLB/H) ',12F9.2,
     *          /,1H ,4X,'PM DWF BOD (KLB/H) ',12F9.2,
     *         //,1H ,4X,'AM DWF SS  (KLB/H) ',12F9.2,
     *          /,1H ,4X,'PM DWF SS  (KLB/H) ',12F9.2,
     *         //,1H ,4X,'AM DWF BOD (MG/L)  ',12F9.2,
     *          /,1H ,4X,'PM DWF BOD (MG/L)  ',12F9.2,
```

Table A-1 (Continued)

```
     *         //,1H ,4X,'AM DWF SS  (MG/L)  ',12F9.2,
     *          /,1H ,4X,'PM DWF SS  (MG/L)  ',12F9.2,//,5X,127('-'))
C
C***** END OF INITIAL READ CARDS FINISH WRITING PRELIMINARY INFORMATION
C
C         PRINT DWF TREATMENT PLANT CAPACITY INFORMATION
C
        DWFT = 0.0
        DWBT = 0.0
        DWST = 0.0
        DWFPK = 0.0
        DWBPK = 0.0
        DWSPK = 0.0
      DO 496  J=1,24
        DWFT = DWFT + DWF(J)
        DWBT = DWBT + DWFB(J)
        DWST = DWST + DWFS(J)
      IF (DWF(J)  .GT. DWFPK)  DWFPK = DWF(J)
      IF (DWFB(J) .GT. DWBPK)  DWBPK = DWFB(J)
  496 IF (DWFS(J) .GT. DWSPK)  DWSPK = DWFS(J)
        DWFPKD = 24.0*DWFPK
        DWBPKD = 24.0*DWBPK
        DWSPKD = 24.0*DWSPK
        DWTRTH = DWTRT/24.0
      WRITE(N9,64)  DWTRT,DWTRTH,DWFPKD,DWFPK,DWBPKD,DWBPK,
     *             DWSPKD,DWSPK,DWFT,DWBT,DWST
   64 FORMAT( ///,1H ,62X,'FLOW',12X,'BOD',14X,'SS',
     *          /,1H ,35X,'DWF',16X,3(3X,'-------------'),
     *          /,1H ,59X,'MGD    MGH ',2('    KLB/D  KLB/H'),
     *          /,1H ,29X,25('-'),3('   ------ ------'),
     *         //,1H ,29X,'TREATMENT CAPACITY (PS 1)',F9.2,F7.3,
     *          /,1H ,29X,'PEAK FLOWRATE',12X,3(F9.2,F7.3),
     *          /,1H ,29X,'DAILY TOTAL',14X,3(F9.2,7X),
     *         //,1H ,29X,25('-'),3('   ------ ------'))
      IF (DWFPKD .GT. DWTRT)  WRITE(N9,75)
   75 FORMAT(   /,1H ,25X,'*** WARNING ***',14X,
     *             'DWF PEAK FLOWRATE EXCEEDS DWF TREATMENT CAPACITY')
      IF (MODE .NE. 2)  GO TO 500
        I = 2
  497   I = I + 1
      IF (I .EQ. 8)  GO TO 500
      IF (VOLOFF(I-2) .EQ. 0.0)  GO TO 497
      IF (VOLOFF(I-2) .LT. DWFPK)  WRITE(N9,81)
   81 FORMAT(///,1H ,'WARNING  ***  THE MIN +VE PUMP OFF VOL CONTROL',
     *      ' SPECIFIED WILL REQUIRE WWF PUMP STAGES (ABOVE STAGE 1)',
     *      ' TO HANDLE THE PEAK DWF')
C
C          WRITE:  TREATMENT CHARACTERISTICS
C
  500 GO TO (510,520), ITREAT
  510 WRITE(N9,66)  ITREAT,REMTRB,REMTRS
   66 FORMAT(1H1,/,1X,'TREATMENT:',/,1H+,10('_'),
     *         //,56X,'TREATMENT OPTION = ',I1,//,52X,29('-'),
     *          /,56X,'REMOVAL EFFICIENCY, %',/,56X,21('-'),
     *       /,60X,'BOD',6X,'SS',/,60X,'---',6X,'--',
     *      //,57X,2F8.2,//,52X,29('-'))
      GO TO 560
  520 WRITE(N9,84)  ITREAT,TRBC,TRSC
   84 FORMAT(1H1,'TREATMENT:',/,1H+,10('_'),
     *         //,56X,'TREATMENT OPTION = ',I1,//,52X,29('-'),
```

Table A-1 (Continued)

```
     *          /,57X,'MAXIMUM EFFLUENT',
     *          /,56X,'CONCENTRATION,MG/L',/,56X,18('-'),
     *          /,60X,'BOD',6X,'SS',/,60X,'---',6X,'--',
     *         //,57X,2F8.2,//,52X,29('-'))
C
C       WRITE INPUT/OUTPUT FILE INFORMATION AND TRAVEL DELAYS
C
  560 WRITE(N9,77)  N1,N2,N3,N4,N5,N6,N7, N5,N1,N2,N3,N4,NTRAV,N6,N7
   77 FORMAT(////,1H ,'INPUT/OUTPUT FILES:',/,1H+,19('_'),
     *         //,1H ,39X,'SUMMARY OF I/O FILE NUMBERS:',
     *         /,1H ,57X,28('-')/,1H ,58X,'N1  N2  N3  N4  N5  N6  N7',
     *          /,1H ,56X,7I4,/,1H ,57X,28('-'),
     *         //,1H ,39X,'RAIN INPUT FILE:',/,1H0,57X,23('-'),
     *          /,1H ,58X,'FILE NAME',10X,'N5',
     *          /,1H ,58X,'FILE NUMBER',6X,I4,/,1H ,57X,23('-'),
     *        //,1H0,39X,'LATERAL INFLOW INPUT FILES, & FLOW ROUTING:',
     *          /,1H0,57X,35('-'),/,1H ,58X,'FILE NAME',10X,
     *          'N1  N2  N3  N4',/,1H ,58X,'FILE NUMBER',6X,4I4,
     *          /,1H ,58X,'TIME DELAY, HR.',2X,4I4,/,1H ,57X,35('-'),
     *         //,1H0,39X,'OUTFLOW OUTPUT FILES:',/,1H0,57X,35('-'),
     *          /,1H ,58X,'OUTFLOW TYPE    PUMPED   OVERFLOW',
     *          /,1H ,58X,'FILE NAME',9X, 'N6',8X,'N7',
     *          /,1H ,58X,'FILE NUMBER',7X,I2,8X,I2,/,1H ,57X,35('-'))
      DO 570  L=1,4
      IF (NTRAV(L) .LT. 0 .OR. NTRAV(L) .GT. 24)  GO TO 580
  570 CONTINUE
      GO TO 600
C
C       WRITE ERROR MESSAGE
C
  580 WRITE(N9,78)
   78 FORMAT(1H0,5X,'***  ROUTING ERROR:  A TIME DELAY IS ',
     *       'OUT OF PERMITTED 0-TO-24 HR RANGE')
      STOP
C
C       WRITE STORAGE OPERATING MODE AND POLLUTANT REMOVAL EFFICIENCY
C
  600   MODE1 = MODE + 1
      GO TO (610,610,620), MODE1
  610 WRITE(N9,74)  MODE,MODES(MODE+1)
   74 FORMAT(1H1,/,1X,'STORAGE OPERATING MODE:',/,1H+,23('_'),
     *         //,52X,'MODE =',I2,' = ',A4,'MUM FLOW DELAY')
      IF (MODE .EQ. 1)  WRITE(N9,71)  MSTDRY,STCRIT
   71 FORMAT(//,1H ,47X,28HDRY PERIOD FOR EVENT DEF'N =,I3,' HOURS',
     *       //,1H ,48X,'THRESHOLD STORAGE =',F6.1,' MIL GAL')
      GO TO 629
  620 WRITE(N9,80)  MODE
   80 FORMAT(1H1,'STORAGE OPERATING MODE:',/,1H+,23('_'),
     *         //,50X,'MODE =',I2,' = VOLUME SWITCH CONTROLLED')
  629 WRITE(N9,179) REMSTB,REMSTS
  179 FORMAT (1H ,/,52X,30('-'),/,53X,'STORAGE REMOVAL EFFICIENCY %',
     *            /,56X,22('-'),/,60X,'BOD',8X,'SS',/,60X,'---',8X,
     *            '--',//,60X,F4.1,6X,F4.1,//,52X,30('-'))
C
C  VERIFY MINIMUM TYPE C OVERFLOW SEPARATION VALUE
C
      IF (MOVSEP .LT. 0) WRITE(N9,87)
C
C        WRITE ERROR MESSAGE
C
```

Table A-1 (Continued)

```
   87 FORMAT(//,1H0,'*** ERROR: INCONSISTENCY IN MOVSEP, VALUE OF',
     *' MINIMUM TYPE C OVERFLOW SEPARATION')
C
C         WRITE:  QUALITY PRINT OPTIONS SELECTED
C
  630 WRITE(N9,85)IQL1P,(QOPT(L,IQL1),L=1,2),IQL2P,(QOPT(L,IQL2),L=1,2)
     *          ,IQL3P,(QOPT(L,IQL3),L=1,2)
   85 FORMAT(/////,1H ,'QUALITY PRINT OPTIONS SELECTED:',
     *          /,1H+,31('_'),/,1H0,38X,57('-'),
     *          /,40X,'COLUMNS',11X,'1-2',12X,'3-4',12X,'5-6',
     *          /,40X,'UNITS',13X,'KLB',12X,'KLB',11X,'MG/L',
     *          /,40X,'VARIABLE',3X,3(3X,I1,' = ',2A4),
     *          /,1H ,38X,57('-'))
C
C        SUBROUTINE CALL
C
       CALL HOURLY
C
C @      UPDATE POINTERS ON RAINFILE, AND OUTPUT FILES
C        NOTE:  UPDATING OF THESE FILES CAN BE DONE AT THE BEGINNING
C               OF SUBROUTINE HOURLY.  REMOVE THESE LINES IN THAT CASE
      IF (N5 .NE. N8)  REWIND N5
      IF (N6 .GT. 0)  REWIND N6
      IF (N7 .GT. 0)  REWIND N7
C
C        END OF SUBAREA LOOP
C
99999 CONTINUE
C
C        WRITE LAST LINE INDICATING END OF PROGRAM
C
      WRITE(N9,82)
   82 FORMAT(1H1,5X,24HEPAMAC1 SIMULATION ENDED,
     *////)
90909 RETURN
C***** END OF MAIN PROGRAM
      END
C-----------------------------------------------------------------
      BLOCK DATA
      COMMON  /QOPTS/  QOPT(2,4)
      DATA QOPT/' RUN','OFF ',
     *          'OVER','FLOW',
     *          'TREA','TED ',
     *          '    ','    '/
      END
C-----------------------------------------------------------------
C
C***** BEGIN SUBROUTINE
C
C     NOTE:  SUBROUTINE CONTAINS STOP STATEMENTS.  IF REQUIRED FOR
C            COMPUTER FACILITY, REPLACE THE STOP STATMENTS WITH
C            GO TO 90909 STATEMENTS TO EXIT SUBROUTINE. ALSO ADD
C            FLAG TO PROGRAM TO SIGNAL WHEN SUBROUTINE IS EXITING
C            WITH THIS TYPE OF ERROR.  WHEN MAIN PROGRAM RECOGNIZES
C            A RETURN WITH EXIT EXECUTE A GO TO 90909 STATEMENT IN
C            MAIN TO PREVENT ADDITIONAL SUBAREA RUNS.
C
      SUBROUTINE HOURLY
C
```

Table A-1 (Continued)

```
C         CALLED ONCE FOR EACH SUBAREA
C
      DIMENSION  NDPM(12),RAIN(24),WMONTH(12),STORB(7),
     *     TRD24(24),OVF24(24),
     *     TRB24(24),OVB24(24),TRS24(24),OVS24(24),
     *     HPRNTB(3),DPRNTB(3),MPRNTB(3),YPRNTB(3),RPRNTB(3),
     *     HPRNTS(3),DPRNTS(3),MPRNTS(3),YPRNTS(3),RPRNTS(3),
     *      HFLO1(24), HFLO2(24), HFLO3(24), HFLO4(24),
     *     HQSAV1(24),HQSAV2(24),HQSAV3(24),HQSAV4(24),
     *      HINQ1(24), HINQ2(24), HINQ3(24), HINQ4(24),
     *      HBOD1(24), HBOD2(24), HBOD3(24), HBOD4(24),
     *     HBSAV1(24),HBSAV2(24),HBSAV3(24),HBSAV4(24),
     *      HINB1(24), HINB2(24), HINB3(24), HINB4(24),
     *       HSS1(24),  HSS2(24),  HSS3(24),  HSS4(24),
     *     HSSAV1(24),HSSAV2(24),HSSAV3(24),HSSAV4(24),
     *      HINS1(24), HINS2(24), HINS3(24), HINS4(24)
      COMMON  STMAX,STCRIT,COEFX,BCONC(3),SCONC(3),MRODRY,RAINMN,
     *     RFAC,WNAME(5),WASHED(5),MOVSEP,MSTDRY,MODE,FREQ(2),IPRINT,
     *     N1,N2,N3,N4,N5,N6,N7,N8,N9,IQUAL(3),IQL1,IQL2,IQL3,NTRAV(4),
     *     ITREAT,REMTRB,REMTRS,TRBC,TRSC,NWTYR,REMSTB,REMSTS,
     *     PUMP(7),VOLON(5),VOLOFF(5),DWF(24),DWFB(24),DWFS(24)
      COMMON  /QOPTS/  QOPT(2,4)
      INTEGER  YDATA,DDATA,YDATAP,DDATAP,YPRES,DPRES,HPRES,YBEGIN,YEND,
     *         YDATA1,YDATA2,YDATA3,YDATA4,DDATA1,DDATA2,DDATA3,DDATA4,
     *         YEVNTA,REVNTA,YEVNTB,REVNTB,HSTAGE,DSTAGE,YSTAGE,RSTAGE,
     *         MEVNTC,YEVNTC,REVNTC,CCOUNT,CTRIGR,MNTYR
      REAL*8   RROB,RROS,RRUNOF,RDWB,RDWS,RDWF,RLIB,RLIS,RLIF,
     *         RINB,RINS,RINF,RTRB,RTRS,RTRTD,ROFB,ROFS,ROVFL,YRANE,
     *         YRUNOF,YTRTD,YOVFL,YPRNTB,YPRNTS,RRANE,RPRNTB,RPRNTS
      REAL*8   MRANE,MRUNOF,MTRTD,MOVFL,MSTOR,MPRNTB,MPRNTS,
     *         NHTRTD,NDTRTD,NMTRTD,NYTRTD,NRTRTD
      DATA WMONTH/'JAN.','FEB.','MAR.','APR.','MAY ','JUNE','JULY',
     *            'AUG.','SEP.','OCT.','NOV.','DEC.'/
      DATA NDPM/31,28,31,30,31,30,31,31,30,31,30,31/
C
C     DEFINITION OF PRINCIPAL VARIABLES
C     (AN INITIAL 'N' INDICATES HOURS)
C     (AN INITIAL "R" INDICATES SUBAREA VARIABLE -NONE SHOWN IN TABLE)
C
C         DESCRIPTION          HOURLY    DAILY     MONTHLY    YEARLY
C
C         PRESENT DATE          HPRES    DPRES      MPRES      YPRES
C         RAIN, IN.             HRANE    DRANE      MRANE      YRANE
C         RAIN, HRS            NHRANE    NDRANE     NMRANE     NYRANE
C         RUNOFF, MGAL          HRUNOF   DRUNOF     MRUNOF     YRUNOF
C         RUNOFF, HRS             -        -          -          -
C         TREATED, MGAL         HTRTD    DTRTD      MTRTD      YTRTD
C         TREATED, HRS         NHTRTD    NDTRTD     NMTRTD     NYTRTD
C         OVERFLOW, MGAL        HOVFL    DOVFL      MOVFL      YOVFL
C         OVERFLOW, HRS        NHOVFL    NDOVFL     NMOVFL     NYOVFL
C         MAX STORAGE, MGAL     HSTOR    DSTOR      MSTOR      YSTOR
C         POLLUT. LOAD, KLB     HPOLL    DPOLL      MPOLL      YPOLL
C         TREAT RATE, MGAL/HR   HPUMP      -          -          -
C         MAX PUMP STAGE        HSTAGE   DSTAGE     MSTAGE     YSTAGE
C
C          IF DATA IS TO BE READ FROM DISK, INITIALIZE POINTER
C  a   DECLARE OR OPEN LATERAL INFLOW FILES HERE IF REQUIRED
C
      IF (N1 .NE. 0) REWIND N1
      IF (N2 .NE. 0) REWIND N2
```

Table A-1 (Continued)

```
      IF (N3 .NE. 0) REWIND N3
      IF (N4 .NE. 0) REWIND N4
C
C      CARD GROUP NO. 12 OR SEPARATE RAIN FILE
C     @    READ AND SCREEN FIRST RAIN DATA CARD (RAIN IN 0.01 IN./HR)
C
      IF (N5.NE.N3) READ(N5,50)  YDATA,MDATA.DDATA,(RAIN(J),J=1,24)
      IF (N5.EQ.N3) READ(N5,51)  YDATA,MDATA,DDATA,(RAIN(J),J=1,24)
   50 FORMAT(9X,I3,2I2,4X,24F4.2)
   51 FORMAT(9X,I3,2I2,4X,15F4.2,/,20X,9F4.2)
      IF (YDATA .EQ. 999)  GO TO 900
      IF (YDATA .EQ. 4*IFIX(0.001+0.25*(FLOAT(YDATA))) .AND.
     *    MDATA .EQ. 2 .AND. DDATA .EQ. 29)  GO TO 7
      IF (DDATA .LE. NDPM(MDATA) .AND. DDATA .GT. 0)  GO TO 7
C
C        WRITE ERROR MESSAGE
C
    5 WRITE(N9,61)  YDATA,MDATA,DDATA
   61 FORMAT(1H0,'LAST (PROBLEM?) DATA CARD READ CONTAINS',
     *        ' YEAR,MONTH,DAY =',3I3)
      STOP
C
C***** BEGIN INITIALIZATION AND HEADING CONTROL
C
C           OTHER PRELIMINARY (SUBAREA) INITIALIZATION
    7 DO 15  I=2,7
   15   PUMP(I) = PUMP(I)/24.0
C
       IF (MNTYR.NE. 0) GO TO 150
       MNTYR = MDATA
  150  CONTINUE
C
C           PRINT WATER YEAR STARTING MONTH
C
      WRITE(N9,185) MNTYR
  185 FORMAT(1H ,////,6X,'WATER YEAR STARTING MONTH DEFINITION = ',I2)
C
        YHEADG = 15
        YPRES = YDATA
        MPRES = MDATA
        DPRES = DDATA
        YDATAP = YDATA
        MDATAP = MDATA
        DDATAP = DDATA
        RRANE  = 0.0
        NRRANE = 0
        RRUNOF = 0.0
        RDNF   = 0.0
        RLIF   = 0.0
        RINF   = 0.0
        RTRTD  = 0.0
        NRTRTD = 0.0
        ROVFL  = 0.0
        NROVFL = 0
        RSTOR  = 0.0
      DO 20  I=1,3
        RPRNTB(I) = 0.0
   20   RPRNTS(I) = 0.0
        RROB  = 0.0
        RROS  = 0.0
```

Table A-1 (Continued)

```
        RDWB  = 0.0                                                    HOUR 134
        RDWS  = 0.0                                                    HOUR 135
        RLIB  = 0.0                                                    HOUR 136
        RLIS  = 0.0                                                    HOUR 137
        RINB  = 0.0                                                    HOUR 138
        RINS  = 0.0                                                    HOUR 139
        RTRB  = 0.0                                                    HOUR 140
        RTRS  = 0.0                                                    HOUR 141
        ROFB  = 0.0                                                    HOUR 142
        ROFS  = 0.0                                                    HOUR 143
        REVNTA = 0                                                     HOUR 144
        REVNTB = 0                                                     HOUR 145
        REVNTC = 0                                                     HOUR 146
        CTRIGR = 1                                                     HOUR 147
        CCOUNT = 0                                                     HOUR 148
        NHOVFP = 0                                                     HOUR 149
        HSTOR  = 0.0                                                   HOUR 150
        HSTORB = 0.0                                                   HOUR 151
        HSTORS = 0.0                                                   HOUR 152
        NDRY   = 9000                                                  HOUR 153
        MDRY = 9000                                                    HOUR 154
        MWET = 0                                                       HOUR 155
        MSUB = 3                                                       HOUR 156
        MPREV  = 0                                                     HOUR 157
        MSTART = 1                                                     HOUR 158
        RSTAGE = 0                                                     HOUR 159
      DO 30  J=1,24                                                    HOUR 160
        HFLO1(J) = 0.0                                                 HOUR 161
        HFLO2(J) = 0.0                                                 HOUR 162
        HFLO3(J) = 0.0                                                 HOUR 163
        HFLO4(J) = 0.0                                                 HOUR 164
        HINQ1(J) = 0.0                                                 HOUR 165
        HINQ2(J) = 0.0                                                 HOUR 166
        HINQ3(J) = 0.0                                                 HOUR 167
        HINQ4(J) = 0.0                                                 HOUR 168
        HBOD1(J) = 0.0                                                 HOUR 169
        HBOD2(J) = 0.0                                                 HOUR 170
        HBOD3(J) = 0.0                                                 HOUR 171
        HBOD4(J) = 0.0                                                 HOUR 172
        HINB1(J) = 0.0                                                 HOUR 173
        HINB2(J) = 0.0                                                 HOUR 174
        HINB3(J) = 0.0                                                 HOUR 175
        HINB4(J) = 0.0                                                 HOUR 176
        HSS1(J)  = 0.0                                                 HOUR 177
        HSS2(J)  = 0.0                                                 HOUR 178
        HSS3(J)  = 0.0                                                 HOUR 179
        HSS4(J)  = 0.0                                                 HOUR 180
        HINS1(J) = 0.0                                                 HOUR 181
        HINS2(J) = 0.0                                                 HOUR 182
        HINS3(J) = 0.0                                                 HOUR 183
 30     HINS4(J) = 0.0                                                 HOUR 184
      DO 40  J=1,10                                                    HOUR 185
        HQSAV1(J) = 0.0                                                HOUR 186
        HQSAV2(J) = 0.0                                                HOUR 187
        HQSAV3(J) = 0.0                                                HOUR 188
        HQSAV4(J) = 0.0                                                HOUR 189
        HBSAV1(J) = 0.0                                                HOUR 190
        HBSAV2(J) = 0.0                                                HOUR 191
        HBSAV3(J) = 0.0                                                HOUR 192
        HBSAV4(J) = 0.0                                                HOUR 193
```

Table A-1 (Continued)

```
      HSSAV1(J) = 0.0
      HSSAV2(J) = 0.0
      HSSAV3(J) = 0.0
   40 HSSAV4(J) = 0.0
      IGAP = 0
      IPREV = 2
      KSTAGE = 1
      KDAYS  = 0
C
C      FINISH INITIAL INPUT PRINTING
C
      WRITE(N9,69)  MPRES,DPRES,YPRES,MOVSEP
   69 FORMAT(//,1H0,5X,'DATE OF FIRST RAIN DATA CARD IS ',2(I2,'/'),I3
     *       ///,1H0,5X,'OVERFLOW TYPE DEFINITIONS:',
     *       //,1H ,9X,'TYPE A:  ENDS AT FIRST HOUR WITHOUT OVERFLOW.',
     *       //,1H ,9X,'TYPE B:  ENDS AT FIRST HOUR WITHOUT OVERFLOW ',
     *       'PROVIDED WITHDRAWAL PUMP STAGE',
     *       /,1H ,18X,'IS ALSO LESS THAN 2 (IE, STORAGE IS EMPTY)',
     *       //,1H ,9X,'TYPE C:  ENDS AFTER ',I2,' HOURS WITHOUT',
     *       ' OVERFLOW')
C
C            WRITE TABLE HEADINGS FOR SUBAREA PRINT OPTION
C
      IF (IFRINT .NE. 5) GO TO 1010
      WRITE(N9,1011) FREQ
1011  FORMAT(1H1,///,14X,43X,2A4,'SUMMARY')
      WRITE(N9,1012) WASHED,(WNAME(I),I=1,5),(QOPT(L,IQL1),L=1,2),
     *              (QOPT(L,IQL2),L=1,2),(QOPT(L,IQL3),L=1,2)
 1012 FORMAT(//,40X, 5A4,10X,5A4,/,
     11X,129('-'),/,50X,'$ = MAXIMUM PUMP STAGE USED',23X,'POLLUTANTS',
     */,80X,50('-'),
     */,82X,2(1X,2A4,' (KLB) '),2A4,' (MG/L)'
     2,/,1X,9X,' RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL',2X,
     3'TREAT  MAX STORAGE  ',1X,3(1X,15('-')),/,13X,'IN.  HRS.  MIL ',
     4'GAL  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL   ',
     5 3(5X,'BOD',6X,'SS'),/,10X,'  ----  ----',
     62X ,'-------  --------  -------  ------  -----  -----------',
     7 3X,6(' -------'),/,1H ,49X,'$')
 1010 CONTINUE
C
 1000 CONTINUE
C
C            WRITE TABLE HEADINGS FOR YEARLY PRINT OPTION
C
      IF (IPRINT .NE. 1.OR.YHEADG .NE. 15) GO TO 1020
      WRITE(N9,1021) FREQ
 1021 FORMAT(1H1,///,14X,43X,2A4,'SUMMARY')
      WRITE(N9,1022)  WASHED,(WNAME(I),I=1,5),(QOPT(L,IQL1),L=1,2),
     *              (QOPT(L,IQL2),L=1,2),(QOPT(L,IQL3),L=1,2)
 1022 FORMAT(//,40X, 5A4,10X,5A4,/,
     11X,129('-'),/,50X,'$ = MAXIMUM PUMP STAGE USED',23X,'POLLUTANTS',
     */,80X,50('-'),
     */,82X,2(1X,2A4,' (KLB) '),2A4,' (MG/L)'
     2,/,1X,'  WATER    RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL
     3TREAT  MAX STORAGE  ',1X,3(1X,15('-')),/,3X,'YEAR',6X,
     * 'IN.  HRS. ',' MIL GAL',
     4'  MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL   ',
     5 3(5X,'BOD',6X,'SS'),/,1X,'---------  ----  ----',
     62X ,'-------  --------  -------  ------  -----  -----------',
     7 3X,6(' -------'),/,1H ,49X,'$')
```

Table A-1 (Continued)

```
      YHEADG = 0
 1020 CONTINUE
C
C          START A NEW WATER YEAR.  FIRST INITIALIZE YEARLY VARIABLES
C
        MBEGIN = MPRES
        YBEGIN = YPRES
        MYR = YPRES + 1900
        YRANE  = 0.0
        NYRANE = 0
        YRUNOF = 0.0
        YTRTD  = 0.0
        NYTRTD = 0.0
        YOVFL  = 0.0
        NYOVFL = 0
        YSTOR  = 0.0
      DO 110  I=1,3
        YPRNTB(I) = 0.0
  110   YPRNTS(I) = 0.0
        YEVNTA = 0
        YEVNTB = 0
        YEVNTC = 0
        YSTAGE = 0
        MHEADG = 1
C
C
C          WRITE TABLE HEADING FOR MONTHLY PRINT OPTION
C
      IF (IPRINT .NE. 2.OR.MHEADG. NE. 1) GO TO 2010
      WRITE(N9,2011) MYR,FREQ
 2011 FORMAT (1H1,///,9X,I5,43X,2A4,' SUMMARY')
      WRITE(N9,2012)  WASHED,(WNAME(I),I=1,5),(QOPT(L,IQL1),L=1,2),
     *             (QOPT(L,IQL2),L=1,2),(QOPT(L,IQL3),L=1,2)
 2012 FORMAT(//,40X, 5A4,10X,5A4,/,
     11X,129('-'),/,50X,'$ = MAXIMUM PUMP STAGE USED',23X,'POLLUTANTS',
     */,80X,50('-'),
     */,82X,2(1X,2A4,' (KLB) '),2A4,' (MG/L)'
     2,/,1X,'  MONTH    RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL
     3TREAT  MAX STORAGE  ',1X,3(1X,15('-')),/,13X,'IN.  HRS.  MIL GAL
     4MIL GAL   MIL GAL  HOURS    HOURS    MIL GAL   ',
     5 3(5X,'BOD',6X,'SS'),/,1X,'---------  ----  ----',
     62X ,'-------  --------  -------  ------  -----  -----------',
     7 3X,6(' --------'),/,1H ,49X,'$')
C
 2010 CONTINUE
C
 2000 CONTINUE
C          START A NEW MONTH.  FIRST INITIALIZE MONTHLY VARIABLES
C
        MRANE  = 0.0
        NMRANE = 0
      DO 230  I=1,3
        MPRNTB(I) = 0.0
  230   MPRNTS(I) = 0.0
        NMOVFL = 0
        NMTRTD = 0.0
        MSTOR  = 0.0
        MRUNOF = 0.0
        MOVFL  = 0.0
        MTRTD  = 0.0
```

Table A-1 (Continued)

```
        MEVNTA = 0
        MEVNTB = 0
        MEVNTC = 0
        MSTAGE = 0
        IHEADG = 1
C
C            ADJUST NDPM(2) (=NO. DAYS IN FEB.) FOR LEAP YEAR
      IF (MPRES .NE. 2)  GO TO 130
        NDPM(2) = 28
      IF(YPRES .NE. 4*IFIX(0.001+0.25*(FLOAT(YPRES))))  GO TO 130
        NDPM(2) = 29
  130 CONTINUE
C
C          WRITE:  TABLE HEADINGS FOR DAILY SUMMARY
C
      IF (IPRINT .NE. 3)  GO TO 3000
      WRITE(N9,71)  WMONTH(MPRES),MYR,FREQ
   71 FORMAT(1H1,///,5X,A4,I5,43X,2A4,' SUMMARY')
      IF (NDPM(MPRES) .EQ. 29)  WRITE(N9,72)
   72 FORMAT(1H+,14X,'(LEAP YEAR)')
      WRITE(N9,601)  WASHED,(WNAME(I),I=1,5),(QOPT(L,IQL1),L=1,2),
     *              (QOPT(L,IQL2),L=1,2),(QOPT(L,IQL3),L=1,2)
  601 FORMAT(//,40X, 5A4,10X,5A4,/,
     11X,129('-'),/,50X,'$ = MAXIMUM PUMP STAGE USED',23X,'POLLUTANTS',
     */,80X,50('-'),
     */,82X,2(1X,2A4,' (KLB) '),2A4,' (MG/L)'
     2,/,1X,'   DAY     RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL
     3TREAT  MAX STORAGE   ',1X,3(1X,15('-')),/,13X,'IN.  HRS.  MIL GAL
     4MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL   ',
     5 3(5X,'BOD',6X,'SS'),/,1X,'---------  ----  ----',
     62X ,'-------  --------  -------  ------  -----  -----------',
     7 3X,6(' -------'),/,1H ,49X,'$')
C
 3000 CONTINUE
C
C          START A NEW DAY.  FIRST INITIALIZE DAILY VARIABLES
C
        NDRANE = 0
        DRANE  = 0.0
        DRUNOF = 0.0
        DOVFL  = 0.0
        DTRTD  = 0.0
        NDOVFL = 0
        NDTRTD = 0
        DSTOR  = 0.0
      DO 330  I=1,3
        DPRNTB(I) = 0.0
  330   DPRNTS(I) = 0.0
        DSTAGE = 0
        KDAYS  = KDAYS + 1
C
C***** BEGINNING OF MAJOR COMPUTATIONAL SECTION
C
C      a   READ FROM DISK FOUR LATERAL INFLOWS, IF PRESCRIBED,
C          CHECK INPUT DATES MATCH FOR RAIN AND LATERAL INFLOWS,
C          AND ESTABLISH DELAYED INPUT FILES (HINXI) FOR FLOW ROUTING
C
      IF (N1 .EQ. 0)  GO TO 340
C
C          FIRST LATERAL INFLOW FILE
```

Table A-1 (Continued)

```
C
      READ(N1)  YDATA1,MDATA1,DDATA1,HFLO1,HBOD1,HSS1
      IF (YPRES .NE. YDATA1 .OR. MPRES .NE. MDATA1 .OR.
     *    DPRES .NE. DDATA1)  GO TO 370
        NDELAY = NTRAV(1)
        NDELY1 = NDELAY + 1
      IF (NDELAY .EQ. 0)  GO TO 335
      DO 333  J=1,NDELAY
        HINB1(J)  = HBSAV1(J)
        HINS1(J)  = HSSAV1(J)
        HINQ1(J)  = HQSAV1(J)
        HBSAV1(J) = HBOD1(24-NDELAY+J)
        HSSAV1(J) =  HSS1(24-NDELAY+J)
 333    HQSAV1(J) = HFLO1(24-NDELAY+J)
 335  DO 337  J=NDELY1,24
        HINB1(J)  = HBOD1(J-NDELAY)
        HINS1(J)  =  HSS1(J-NDELAY)
 337    HINQ1(J)  = HFLO1(J-NDELAY)
 340  IF (N2 .EQ. 0)  GO TO 350
C
C          SECOND LATERAL INFLOW FILE
C
      READ(N2)  YDATA2,MDATA2,DDATA2,HFLO2,HBOD2,HSS2
      IF (YPRES .NE. YDATA2 .OR. MPRES .NE. MDATA2 .OR.
     *    DPRES .NE. DDATA2)  GO TO 370
        NDELAY = NTRAV(2)
        NDELY1 = NDELAY + 1
      IF (NDELAY .EQ. 0)  GO TO 345
      DO 343  J=1,NDELAY
        HINB2(J)  = HBSAV2(J)
        HINS2(J)  = HSSAV2(J)
        HINQ2(J)  = HQSAV2(J)
        HBSAV2(J) = HBOD2(24-NDELAY+J)
        HSSAV2(J) =  HSS2(24-NDELAY+J)
 343    HQSAV2(J) = HFLO2(24-NDELAY+J)
 345  DO 347  J=NDELY1,24
        HINB2(J)  = HBOD2(J-NDELAY)
        HINS2(J)  =  HSS2(J-NDELAY)
 347    HINQ2(J)  = HFLO2(J-NDELAY)
 350  IF (N3 .EQ. 0)  GO TO 360
C
C          THIRD LATERAL INFLOW FILE
C
      READ(N3)  YDATA3,MDATA3,DDATA3,HFLO3,HBOD3,HSS3
      IF (YPRES .NE. YDATA3 .OR. MPRES .NE. MDATA3 .OR.
     *    DPRES .NE. DDATA3)  GO TO 370
        NDELAY = NTRAV(3)
        NDELY1 = NDELAY + 1
      IF (NDELAY .EQ. 0)  GO TO 355
      DO 353  J=1,NDELAY
        HINB3(J)  = HBSAV3(J)
        HINS3(J)  = HSSAV3(J)
        HINQ3(J)  = HQSAV3(J)
        HBSAV3(J) = HBOD3(24-NDELAY+J)
        HSSAV3(J) =  HSS3(24-NDELAY+J)
 353    HQSAV3(J) = HFLO3(24-NDELAY+J)
 355  DO 357  J=NDELY1,24
        HINB3(J)  = HBOD3(J-NDELAY)
        HINS3(J)  =  HSS3(J-NDELAY)
 357    HINQ3(J)  = HFLO3(J-NDELAY)
```

Table A-1 (Continued)

```
  360 IF (N4 .EQ. 0)  GO TO 380
C
C         FOURTH LATERAL INFLOW FILE
C
      READ(N4)  YDATA4,MDATA4,DDATA4,HFLO4,HBOD4,HSS4
      IF (YPRES .NE. YDATA4 .OR. MPRES .NE. MDATA4 .OR.
     *    DPRES .NE. DDATA4)  GO TO 370
        NDELAY = NTRAV(4)
        NDELY1 = NDELAY + 1
      IF (NDELAY .EQ. 0)  GO TO 365
      DO 363  J=1,NDELAY
        HINB4(J)  = HBSAV4(J)
        HINS4(J)  = HSSAV4(J)
        HINQ4(J)  = HQSAV4(J)
        HBSAV4(J) = HBOD4(24-NDELAY+J)
        HSSAV4(J) =  HSS4(24-NDELAY+J)
  363   HQSAV4(J) = HFLO4(24-NDELAY+J)
  365 DO 367  J=NDELY1,24
        HINB4(J)  = HBOD4(J-NDELAY)
        HINS4(J)  =  HSS4(J-NDELAY)
  367   HINQ4(J)  = HFLO4(J-NDELAY)
      GO TO 380
C
C        WRITE ERROR MESSAGE
C
  370  WRITE(N9,70) YPRES,MPRES,DPRES,YDATA1,MDATA1,DDATA1,
     *              YDATA2,MDATA2,DDATA2,YDATA3,MDATA3,DDATA3,
     *              YDATA4,MDATA4,DDATA4
   70 FORMAT(///,1H0,10X,'ERROR:  INPUT DATA MISMATCH AS FOLLOWS:',
     *         /,1H0,T20,'INPUT',T43,'YEAR  MONTH    DAY',
     *         /,1H0,T20,'PRESENT DATE/RAIN',T40,3I7,
     *         /,1H ,T20,'LATERAL INFLOW N1',T40,3I7,
     *         /,1H ,T20,'LATERAL INFLOW N2',T40,3I7,
     *         /,1H ,T20,'LATERAL INFLOW N3',T40,3I7,
     *         /,1H ,T20,'LATERAL INFLOW N4',T40,3I7)
      GO TO 990
C
C         PRINT:  TABLE HEADINGS FOR HOURLY SUMMARY
C
  380 IF (IPRINT .NE. 4 .OR. IHEADG .NE. 1)  GO TO 4000
      WRITE(N9,71)  WMONTH(MPRES),MYR,FREQ
      IF (NDPM(MPRES) .EQ. 29)  WRITE(N9,72)
      WRITE(N9,60)  WASHED,(WNAME(I),I=1,5),(QOPT(L,IQL1),L=1,2),
     *              (QOPT(L,IQL2),L=1,2),(QOPT(L,IQL3),L=1,2)
C
   60 FORMAT(//,40X, 5A4,10X,5A4,/,
     11X,129('-'),/,50X,'$ = MAXIMUM PUMP STAGE USED',23X,'POLLUTANTS',
     */,80X,50('-'),
     */,82X,2(1X,2A4,' (KLB) '),2A4,' (MG/L)'
     2,/,1X,'DAY  HOUR  RAIN  RAIN  RUNOFF   OVERFLOW  TREATED  OVERFL
     3TREAT  MAX STORAGE  ',1X,3(1X,15('-')),/,13X,'IN.  HRS.  MIL GAL
     4MIL GAL   MIL GAL  HOURS   HOURS    MIL GAL   ',
     5 3(5X,'BOD',6X,'SS'),/,1X,'---- ----  ----  ----',
     62X ,'-------  --------  -------  ------  -----  -----------',
     7 3X,6(' -------'),/,1H ,49X,'$')
C
C         DO LOOP FOR PRESENT 24 HOURS
C         BEGIN HOUR LOOP
C
 4000 DO 5555  HPRES=1,24
```

Table A-1 (Continued)

```
C
C          INITIALIZE FOR NEW HOUR STARTED HERE
C
        TRD24(HPRES) = 0.0
        OVF24(HPRES) = 0.0
        TRB24(HPRES) = 0.0
        OVB24(HPRES) = 0.0
        TRS24(HPRES) = 0.0
        OVS24(HPRES) = 0.0
        HTRTD  = 0.0
        HOVFL  = 0.0
        HRUNOF = 0.0
        HROB   = 0.0
        HROS   = 0.0
        HRANE  = 0.0
        NHRANE = 0
        NHOVFL = 0
        NHTRTD = 0.0
        STORAP = HSTOR
C
C          COMPUTE RUNOFF, STORAGE
C
      IF(IGAP .NE. 0)  GO TO 409
C
C          FOR HOURS WITH RAIN DATA ONLY
C
        HRANE=RAIN(HPRES)*RFAC
      IF (HRANE .EQ. 0.0)  GO TO 409
C
C          CUMULATE HOURS OF RAINFALL
C
        NHRANE = 1
        NDRANE = NDRANE + 1
        NMRANE = NMRANE + 1
        NYRANE = NYRANE + 1
        NRRANE = NRRANE + 1
C
C          CUMULATE INCHES OF RAINFALL
C
        DRANE = DRANE + HRANE
        MRANE = MRANE + HRANE
        YRANE = YRANE + HRANE
        RRANE = RRANE + HRANE
        HRUNOF = COEFX*HRANE
C
C          CUMULATE RUNOFF VOLUME
C
        DRUNOF = DRUNOF + HRUNOF
        MRUNOF = MRUNOF + HRUNOF
        YRUNOF = YRUNOF + HRUNOF
        RRUNOF = RRUNOF + HRUNOF
C
C          ADD IN THE LATERAL INFLOW VOLUMES
C
  409   HDWF   = DWF(HPRES)
        HLIF   = HINQ1(HPRES) + HINQ2(HPRES) +HINQ3(HPRES)+HINQ4(HPRES)
        HINF   = HRUNOF + HDWF + HLIF
        STORA  = HINF + HSTOR
C
        RDWF   = RDWF + HDWF
```

Table A-1 (Continued)

```
        RLIF   = RLIF + HLIF
        RINF   = RINF + HINF
C
C           COMPUTE STORAGE, WITHDRAWAL (TREATMENT), OVERFLOW,
C           INCLUDES SELECTION OF OPTIMUM PUMPING RATE BASED ON
C           VALUE OF MODE
C
C          PUMP SELECTION
C
      IF (MODE .EQ. 2)  GO TO 420
C
C           CUMULATE DRY STORAGE HOURS
C
      IF (STORA .LT. 0.000001 .AND. STORAP .GT. 0.000001)  NDRY = 0
      IF (STORA .GT. STCRIT .AND. STORAP .LE. STCRIT)  NDRY = 0
      IF (STORA .LT. 0.000001)  NDRY = NDRY + 1
C
C           CHECK FOR PUMP DELAY AT START OF STORM
C
      IF (MODE .EQ. 0)  GO TO 410
      IF (NDRY .LT. MSTDRY)  GO TO 410
      IF (STORA .GT. STCRIT)  GO TO 410
C
C           DELAY PUMPING AT START OF STORM (MIN PUMP = DWTRT)
C
        HPUMP = PUMP(2)
        HSTAGE = 1
      GO TO 440
  410   STORB(1) = STORA
      DO 411  I=2,7
  411   STORB(I) = STORA - PUMP(I)
C
C           SELECT PRES PUMP RATE WHICH MINIMIZES O'FLOWS
C
      IF (STORB(1) .GE. 0.0)  GO TO 412
C           (1)  ALL PUMP OPTIONS DRY OUT STORAGE; CHOOSE SLOWEST
        HPUMP = 0.0
        HSTAGE = 0
      GO TO 440
  412 IF (STORB(7) .LT. 0.0)  GO TO 413
C           (2)  NO PUMP OPTIONS DRY OUT STORAGE
      IF (MODE .EQ. 1)  GO TO 416
C
C           PUMP OUT MAX POSS, FOR MIN DELAY (MODE=0)
C
        HPUMP = PUMP(7)
        HSTAGE = 6
      GO TO 440
C           (3)  SOME PUMP OPTIONS DRY OUT STORAGE, OTHERS DON'T
  413 IF (MODE .EQ. 1)  GO TO 416
C
C           FIND MAX STORB .LT. 0, FOR MIN DELAY (MODE=0)
C
        I = 1
  414 IF (STORB(I) .LE. 0.0)  GO TO 415
        I = I + 1
      GO TO 414
  415   HPUMP = PUMP(I)
        HSTAGE = I-1
      GO TO 440
```

Table A-1 (Continued)

```
C
C         FIND MIN PUMP RATE, FOR MAX DELAY (MODE=1) W/O O'FLOW
C
  416   I = 2
  417 IF (STORB(I) .LE. STMAX)  GO TO 418
      IF (I .EQ. 7)  GO TO 418
        I = I + 1
      GO TO 417
  418   HPUMP = PUMP(I)
        HSTAGE = I-1
      GO TO 440
C
C         FOR MODE = 2  (VOLUME SWITCH CONTROL)
C
  420   I = 3
  421 IF (VOLON(I-2) .GT. STORA)  GO TO 429
      IF (I .EQ. 7)  GO TO 430
        I = I + 1
      GO TO 421
  429   I = I - 1
        IPRE = I
      IF (I .GT. 2 .AND. VOLON(I-2) .EQ. 0.0)  I = 2
  430 IF (I .GE. IPREV)  GO TO 439
C         STORAGE IS DECREASING
        I = IPREV
  435 IF (I .EQ. 2)  GO TO 439
      IF (STORA .GT. VOLOFF(I-2))  GO TO 438
        I = I - 1
      GO TO 435
  438   IPRE = I
      IF (VOLOFF(I-2) .EQ. 0.0)  I = 2
  439   HPUMP = PUMP(I)
        HSTAGE = I-1
        IPREV = IPRE
C
C        ESTABLISH FLOW ASSIGNMENTS TO STORAGE AND TREATMENT
C
  440   HSTOR = STORA - HPUMP
      IF (HSTOR .GT. 0.0)  GO TO 450
        HSTOR = 0.0
C
  450   HTRTD = STORA - HSTOR
        TRD24(HPRES) = HTRTD
      IF (HPUMP .EQ. 0.0)  GO TO 460
C
C          CUMULATE HOURS TREATED
C
        NHTRTD = HTRTD/HPUMP
        NDTRTD = NDTRTD + NHTRTD
        NMTRTD = NMTRTD + NHTRTD
        NYTRTD = NYTRTD + NHTRTD
        NRTRTD = NRTRTD + NHTRTD
C
C          CUMULATE TREATED VOLUME
C
        DTRTD = DTRTD + HTRTD
        MTRTD = MTRTD + HTRTD
        YTRTD = YTRTD + HTRTD
        RTRTD = RTRTD + HTRTD
C
```

Table A-1 (Continued)

```
C        ESTABLISH OVERFLOW VOLUME
C
  460   STOROV = HSTOR - STMAX
C     SET UP COUNTER FOR OVERFLOW EVENT TYPE C (EVENTC)
      IF (STOROV .LE. 0) GO TO 461
        CCOUNT = 0
      GO TO 462
  461   CCOUNT = CCOUNT + 1
      IF (CCOUNT .GE. MOVSEP) CTRIGR = 1
  462 IF (HSTAGE .LT. 2)  KSTAGE = 1
      IF (STOROV .LE. 0.0)  GO TO 470
C
C        OVERFLOW EVENT OCCURED
C
C          CUMULATE HOURS OF OVERFLOW
C
        NDOVFL = NDOVFL + 1
        NMOVFL = NMOVFL + 1
        NYOVFL = NYOVFL + 1
        NROVFL = NROVFL + 1
        NHOVFL = 1
C
C          PROCESS OVERFLOW EVENT COUNTERS
C
      IF (NHOVFL .LE. NHOVFP)  GO TO 465
        YEVNTA = YEVNTA + 1
        REVNTA = REVNTA + 1
        MEVNTA = MEVNTA + 1
      IF (CTRIGR .NE. 1)  GO TO 463
        CTRIGR = 0
        MEVNTC = MEVNTC + 1
        YEVNTC = YEVNTC + 1
        REVNTC = REVNTC + 1
  463 IF (KSTAGE .NE. 1)  GO TO 465
        KSTAGE = 0
        YEVNTB = YEVNTB + 1
        REVNTB = REVNTB + 1
        MEVNTB = MEVNTB + 1
C
C          CUMULATE OVERFLOW VOLUME
C
  465   HOVFL = STOROV
        DOVFL = DOVFL + STOROV
        MOVFL = MOVFL + STOROV
        YOVFL = YOVFL + STOROV
        ROVFL = ROVFL + STOROV
        HSTOR = STMAX
  470   NHOVFP = NHOVFL
        OVF24(HPRES) = HOVFL
C
C          ASSIGN MAXIMUM VALUES TO STORAGE VOLUME
C
      IF (HSTOR .GT. DSTOR)  DSTOR = HSTOR
      IF (HSTOR .GT. MSTOR)  MSTOR = HSTOR
      IF (HSTOR .GT. YSTOR)  YSTOR = HSTOR
      IF (HSTOR .GT. RSTOR)  RSTOR = HSTOR
C
C          ASSIGN MAXIMUM VALUES TO PUMP STAGE
C
      IF (HSTAGE .GT. DSTAGE)  DSTAGE = HSTAGE
```

Table A-1 (Continued)

```
      IF (HSTAGE .GT. MSTAGE)  MSTAGE = HSTAGE
      IF (HSTAGE .GT. YSTAGE)  YSTAGE = HSTAGE
      IF (HSTAGE .GT. RSTAGE)  RSTAGE = HSTAGE
C
C          COMPUTE POLLUTANT LOADS IN RUNOFF (KLB)
C          USE MRODRY AND RAINMN TO TRIGGER RESET OF CONCENTRATIONS
C
      IF (HRUNOF .GT. 0.000001)  GO TO 471
        MDRY = MDRY + 1
        MWET = 0
      GO TO 472
 471    MDRY = 0
        MWET = MWET + 1
C
 472  IF (MWET .EQ. 0 .AND. MDRY .GE. MRODRY)  MSTART = 1
      IF (MWET .EQ. 0 .AND. MDRY .EQ. 1)  MSTART = 0
C          FIND MSUB = HOUR FOR RUNOFF CONCENTRATION
      IF (MPREV .EQ. 1)  MSUB = MSUB + 1
      IF (MSUB  .GT. 3)  MSUB = 3
      IF (MSTART .EQ. 1 .AND. MWET .EQ. 1)  MSUB = 1
        MPREV = 0
      IF (HRANE .GT. RAINMN)  MPREV = 1
C
      IF (MWET .EQ. 0)  GO TO 473
        HROB = HRUNOF*BCONC(MSUB)*8.345/1000.0
        HROS = HRUNOF*SCONC(MSUB)*8.345/1000.0
C
C          COMPUTE POLLUTANT LOADS IN STORAGE AND OUTFLOWS (KLB),
C          ASSUMING COMPLETE MIXING IN STORAGE
C
 473    HDWB   = DWFB(HPRES)
        HLIB   = HINB1(HPRES) + HINB2(HPRES) +HINB3(HPRES)+HINB4(HPRES)
        HINB   = HROB + HDWB + HLIB
        STORBA = HINB + HSTORB
        HDWS   = DWFS(HPRES)
        HLIS   = HINS1(HPRES) + HINS2(HPRES) +HINS3(HPRES)+HINS4(HPRES)
        HINS   = HROS + HDWS + HLIS
        STORSA = HINS + HSTORS
      IF (STORA .EQ. 0.0)  GO TO 474
        RB = STORBA/STORA
        RS = STORSA/STORA
      GO TO 475
 474    RB = 0.0
        RS = 0.0
C
C     COMPUTE CONSTITUENT LOADS IN OVERFLOW (KLB)
C     ADJUST STORAGE LOAD IF NECESSARY
C
  475 HOFB = RB*HOVFL*(1.0 - REMSTB/100.0)
      HOFS = RS*HOVFL*(1.0 - REMSTS/100.0)
      OVB24(HPRES) = HOFB
      OVS24(HPRES) = HOFS
C      IF (STORA .EQ. 0) GO TO 1474
      IF (HTRTD.LE.0.AND.HSTOR.LE.0) GO TO 1475
      IF (REMSTB.GT.0)RB = (STORBA-HOFB)/(HTRTD+HSTOR)
      IF (REMSTS.GT.0)RS = (STORSA-HOFS)/(HTRTD+HSTOR)
      GO TO 1475
C 1474 RB = 0.0
C        RS = 0.0
 1475 HSTORB = RB*HSTOR
```

Table A-1 (Continued)

```
      HSTORS = RS*HSTOR
C
C          COMPUTE CONSTITUENT LOADS IN TREATED EFFLUENT (KLB)
C
      GO TO (480,490), ITREAT
C          ITREAT = 1:  REMOVAL EFFICIENCY SPECIFIED (DEFAULT 0%)
  480   HTRB = RB*HTRTD*(1.0-REMTRB/100.0)
        HTRS = RS*HTRTD*(1.0-REMTRS/100.0)
      GO TO 500
C          ITREAT = 2:  EFFLUENT CONCENTRATION SPECIFIED
  490   QQCB = TRBC*8.345/1000.0
        HTRB = QQCB*HTRTD
      IF (RB .LT. QQCB)  HTRB = RB*HTRTD
        QQCS = TRSC*8.345/1000.0
        HTRS = QQCS*HTRTD
      IF (RS .LT. QQCS)  HTRS = RS*HTRTD
  500   TRB24(HPRES) = HTRB
        TRS24(HPRES) = HTRS
C
C            CUMULATE INFLOWS AND OUTFLOWS (KLB)
C
        RROB  = RROB + HROB
        RROS  = RROS + HROS
        RDWB  = RDWB + HDWB
        RDWS  = RDWS + HDWS
        RLIB  = RLIB + HLIB
        RLIS  = RLIS + HLIS
        RINB  = RINB + HINB
        RINS  = RINS + HINS
        RTRB  = RTRB + HTRB
        RTRS  = RTRS + HTRS
        ROFB  = ROFB + HOFB
        ROFS  = ROFS + HOFS
C
C          PREPARE FOR QUALITY PRINTOUT OPTIONS
C
      DO 540  I=1,3
      IF (IQUAL(I) .LT. 4)  GO TO 510
        HPRNTB(I) = 0.0
        HPRNTS(I) = 0.0
      GO TO 540
  510 GO TO (520,520,530), I
C
C          FOR QUALITY PRINT COLUMNS 1-4 (LOAD IN KLB;  I=1,2)
C
  520   IQL = IQUAL(I)
      GO TO (522,524,526), IQL
C          QUALITY LOAD PRINT = RUNOFF (IQUAL = 1)
  522   HPRNTB(I) = HROB
        HPRNTS(I) = HROS
      GO TO 540
C          QUALITY LOAD PRINT = OVERFLOW (IQUAL = 2)
  524   HPRNTB(I) = HOFB
        HPRNTS(I) = HOFS
      GO TO 540
C          QUALITY LOAD PRINT = TREATED (IQUAL = 3)
  526   HPRNTB(I) = HTRB
        HPRNTS(I) = HTRS
      GO TO 540
C
```

Table A-1 (Continued)

```
C          FOR QUALITY PRINT COLUMNS 5-6 (CONCENTRATION IN MG/L;  I=3)
C
  530   IQL = IQUAL(I)
      GO TO (532,534,536), IQL
C          QUALITY CONC PRINT = RUNOFF (IQUAL = 1)
  532 IF (HRUNOF .EQ. 0.0)  GO TO 533
        HPRNTB(3) = (HROB/HRUNOF)*(1000.0/8.345)
        HPRNTS(3) = (HROS/HRUNOF)*(1000.0/8.345)
      GO TO 540
  533   HPRNTB(3) = 0.0
        HPRNTS(3) = 0.0
      GO TO 540
C          QUALITY CONC PRINT = OVERFLOW (IQUAL = 2)
  534 IF (HOVFL .EQ. 0.0)  GO TO 533
        HPRNTB(3) = (HOFB/HOVFL)*(1000.0/8.345)
        HPRNTS(3) = (HOFS/HOVFL)*(1000.0/8.345)
      GO TO 540
C          QUALITY CONC PRINT = TREATED (IQUAL = 3)
  536 IF (HTRTD .EQ. 0.0)  GO TO 533
        HPRNTB(3) = (HTRB/HTRTD)*(1000.0/8.345)
        HPRNTS(3) = (HTRS/HTRTD)*(1000.0/8.345)
  540 CONTINUE
C
C          CUMULATE POLLUTANT LOADS
C
      DO 545  I=1,2
        DPRNTB(I) = DPRNTB(I) + HPRNTB(I)
        DPRNTS(I) = DPRNTS(I) + HPRNTS(I)
        MPRNTB(I) = MPRNTB(I) + HPRNTB(I)
        MPRNTS(I) = MPRNTS(I) + HPRNTS(I)
        YPRNTB(I) = YPRNTB(I) + HPRNTB(I)
        YPRNTS(I) = YPRNTS(I) + HPRNTS(I)
        RPRNTB(I) = RPRNTB(I) + HPRNTB(I)
  545   RPRNTS(I) = RPRNTS(I) + HPRNTS(I)
C
C          ASSIGN MAXIMUM CONCENTRATIONS
C
      IF (HPRNTB(3) .GT. DPRNTB(3))  DPRNTB(3) = HPRNTB(3)
      IF (HPRNTS(3) .GT. DPRNTS(3))  DPRNTS(3) = HPRNTS(3)
      IF (HPRNTB(3) .GT. MPRNTB(3))  MPRNTB(3) = HPRNTB(3)
      IF (HPRNTS(3) .GT. MPRNTS(3))  MPRNTS(3) = HPRNTS(3)
      IF (HPRNTB(3) .GT. YPRNTB(3))  YPRNTB(3) = HPRNTB(3)
      IF (HPRNTS(3) .GT. YPRNTS(3))  YPRNTS(3) = HPRNTS(3)
      IF (HPRNTB(3) .GT. RPRNTB(3))  RPRNTB(3) = HPRNTB(3)
  550 IF (HPRNTS(3) .GT. RPRNTS(3))  RPRNTS(3) = HPRNTS(3)
C
      IF (HRANE .EQ. 0.0 .AND. HOVFL .EQ. 0.0 .AND. HTRTD .EQ. 0.0)
     *   GO TO 5555
C
C          PRINT HOURLY INFORMATION
C
      IF (IPRINT .EQ. 4)  WRITE(N9,64)DPRES,HPRES,HRANE,NHRANE,HRUNOF,
     *     HOVFL,HTRTD,HSTAGE,NHOVFL,NHTRTD,HSTOR,
     *     (HPRNTB(I),HPRNTS(I),I=1,3)
   64 FORMAT(1H ,I3,I5,F7.2,I6,F9.1,2F9.1,I2,I5,F9.1,F12.1,4X,4F8.1,
     *       2F8.1)
C
C***** END HOUR LOOP AND END COMPUTATIONAL SECTION
C      BEGIN PRINT CONTROL AND CALENDAR CHECKING
C
```

Table A-1 (Continued)

```
 5555 CONTINUE
         HPRES = 24
C
C           END OF A DAY
C
C       @   WRITE OUTPUT FILE (N6) TO DISK FOR WITHDRAWALS, IF N6 .GT. 0
C
      IF (N6 .EQ. 0)  GO TO 551
      WRITE(N6)  YPRES,MPRES,DPRES,TRD24,TRB24,TRS24
C
C       @   WRITE OUTPUT FILE (N7) TO DISK FOR OVERFLOWS, IF N7 .GT. 0
C
  551 IF (N7 .EQ. 0)  GO TO 552
      WRITE(N7)  YPRES,MPRES,DPRES,OVF24,OVB24,OVS24
  552 CONTINUE
C
C           SKIP DAILY PRINT IF NO FLOW PROCESSED
C
        IHEADG = 1
      IF (DRANE .EQ. 0.0 .AND. DOVFL .EQ. 0.0 .AND. DTRTD .EQ. 0.0)
     *  IHEADG = 0
      IF (IHEADG .EQ. 0)  GO TO 580
C
C           PRINT DAILY INFORMATION
C
      IF (IPRINT .EQ. 3)  WRITE(N9,62)DPRES,DRANE,NDRANE,DRUNOF,DOVFL,
     *      DTRTD,DSTAGE,NDOVFL,NDTRTD,DSTOR,
     *     (DPRNTB(I),DPRNTS(I),I=1,3)
   62 FORMAT(1H ,3X,I3,2X,F7.2,I6,F9.1,2F9.1,I2,I5,F9.1,F12.1,4X,4F8.1,
     *       2(F7.1,'*'))
      IF (IPRINT .EQ. 4)  WRITE(N9,63)DPRES,DRANE,NDRANE,DRUNOF,DOVFL,
     *      DTRTD,DSTAGE,NDOVFL,NDTRTD,DSTOR,
     *     (DPRNTB(I),DPRNTS(I),I=1,3)
   63 FORMAT(///1X,'DAILY TOTAL (OR MAX*)'//,1X,I3,5X,F7.2,I6,F9.1,
     *     2F9.1,I2,'*',I5,1X,F7.1,F12.1,'*',3X,4F8.1,F8.1,'*',F7.1,'*')
C
C           TEST FOR REMAINING DATA GAP
C
  580 IF (IGAP .NE. 0)  GO TO 600
C
C***** READ IN NEXT DATA AS NEEDED
C       @   ACCESSING RAIN FILE
C
      IF (N5.NE.N8) READ(N5,50)  YDATA,MDATA,DDATA,(RAIN(J),J=1,24)
      IF (N5.EQ.N8) READ(N5,51)  YDATA,MDATA,DDATA,(RAIN(J),J=1,24)
      IF (YDATA .EQ. 999)  GO TO 900
      IF (DDATA .GT. NDPM(MDATA) .OR. DDATA .LE. 0)  GO TO 5
C
C           CHECK IF DATA DATE IS OUT OF SEQUENCE
C
      IF (YDATA - YDATAP)  589,587,590
  587 IF (MDATA - MDATAP)  589,588,590
  588 IF (DDATA .GT. DDATAP)  GO TO 590
C
C           NEW DATA DATE IS OUT OF SEQUENCE
C
C           WRITE ERROR MESSAGE
C
  589 WRITE(N9,73)  YDATA,MDATA,DDATA
   73 FORMAT(1H0,'LAST DATA CARD FOR',3I3,' IS OUT OF SEQUENCE')
```

Table A-1 (Continued)

```
      STOP
  590   YDATAP = YDATA
        MDATAP = MDATA
        DDATAP = DDATA
        IGAP = 1
  600   MEND = MPRES
        YEND = YPRES
C
C          CALENDAR:  INCREMENT PRESENT DATE BY ONE DAY
C
        DPRES = DPRES + 1
      IF (DPRES .LE. NDPM(MPRES))  GO TO 650
        MPRES = MPRES + 1
        DPRES = 1
      IF (MPRES .LE. 12)  GO TO 650
        YPRES = YPRES + 1
        MPRES = 1
C          IS DATA GAP CLOSED?
  650 IF (YPRES .EQ. YDATA .AND. MPRES .EQ. MDATA .AND.
     *    DPRES .EQ. DDATA)  IGAP = 0
C
 6666 IF (DPRES .NE. 1)  GO TO 3000
C
C          END OF A MONTH.  PRINT MONTHLY SUMMARY
C
      IF (IPRINT.EQ.2) WRITE(N9,6700) WMONTH(MEND),MRANE,NMRANE,MRUNOF,
     *                 MOVFL,MTRTD,MSTAGE,NMOVFL,NMTRTD,MSTOR,
     *                (MPRNTB(I),MPRNTS(I),I=1,3),MEVNTA,MEVNTB,MEVNTC
 6700 FORMAT (1H ,2X,A4,2X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,1X,F7.1,F12.1,
     *        '*',3X,5F8.1,'*',F7.1,'*',/,T72,'OVERFLOW EVENTS:  TYPE',
     *        ' A =',I4,', TYPE B =',I4,', TYPE C =',I4)
C
C          SKIP MONTHLY PRINT IF NO FLOW PROCESSED
C
      MHEADG = 1
      IF (MRANE.EQ.0.0.AND.MOVFL.EQ.0.0.AND.MTRTD.EQ.0.0) MHEADG = 0
      IF (MHEADG .EQ. 0) GO TO 7777
C
      IF (IPRINT.EQ.3.OR.IPRINT.EQ.4)  WRITE(N9,67)  WMONTH(MEND),MYR,
     *             MEVNTA,MEVNTB,MEVNTC,
     *             MRANE,NMRANE,MRUNOF,MOVFL,MTRTD,MSTAGE,NMOVFL,
     *             NMTRTD,MSTOR,(MPRNTB(I),MPRNTS(I),I=1,3)
   67 FORMAT(///1X,'MONTHLY TOTAL (OR MAX*) FOR ',A4,I5,
     *   T72,'OVERFLOW EVENTS:  TYPE A =',I4,', TYPE B =',I4,
     *    ', TYPE C =',I4,//,
     *   1H ,8X,F7.2,I6,F9.1,
     *   2F9.1,I2,'*',I5,1X,F7.1,F12.1,'*',3X,4F8.1,F8.1,'*',F7.1,'*')
      MYRP = MYR
      MYR = YPRES + 1900
 7777 IF (MPRES .NE. MWTYR)  GO TO 2000
C
C          END OF A WATER YEAR (7/01-6/30).  PRINT YEARLY SUMMARY
C
      IF (IPRINT .EQ.1.OR.IPRINT.EQ.5) GO TO 6810
C
      WRITE(N9,68)  MBEGIN,YBEGIN,MEND,YEND,
     *             YEVNTA,YEVNTB,YEVNTC,YRANE,NYRANE,YRUNOF,YOVFL,
     *             YTRTD,YSTAGE,
     *             NYOVFL,NYTRTD,YSTOR,(YPRNTB(I),YPRNTS(I),I=1,3)
   68 FORMAT(///1X,'WATER YEAR TOTAL (OR MAX*) FOR',I3,'/',I3,' - ',I2,
```

Table A-1 (Continued)

```
     *     '/',I3,T72,'OVERFLOW EVENTS:  TYPE A =',I4,', TYPE B =',I4,
     *     ', TYPE C =',I4,/,1X,45('-'),
     *      /,1H ,8X,F7.2,I6,F9.1,2F9.1,
     *     I2,'*',I5,1X,F7.1,F12.1,'*',3X,4F8.1,F8.1,'*',F7.1,'*')
 6810  CONTINUE
       IF (IPRINT .EQ. 1) WRITE(N9,6820) MYRP,YRANE,NYRANE,YRUNOF,YOVFL,
     *                    YTRTD,YSTAGE,NYOVFL,NYTRTD,YSTOR,(YFRNTB(I),
     *                    YPRNTS(I),I=1,3),YEVNTA,YEVNTB,YEVNTC
  6820 FORMAT( 1H ,2X,I4,2X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,1X,F7.1,F12.1,
     *        '*',3X,5F8.1,'*',F7.1,'*',/,T72,'OVERFLOW EVENTS:  TYPE',
     *        ' A =',I4,', TYPE B =',I4,', TYPE C =',I4,/)
       IF (IPRINT .EQ. 1) YHEADG = YHEADG + 1
C
C***** RETURN TO NEW WATER YEAR LOOP
C
 8888 GO TO 1000
C
C***** BEGIN FINAL PASS OF FRINTING AND STATISTICS
C
C
C          PRINT:  SUMMARY AT END OF SUBAREA RUN
C                   MONTHLY PRINT
C
   900 IF (IPRINT.EQ.3.OR.IPRINT.EQ.4)  WRITE(N9,77)  WMONTH( MEND),MYR,
     *              MEVNTA,MEVNTB,MEVNTC,
     *              MRANE,NMRANE,MRUNOF,MOVFL,MTRTD,MSTAGE,NMOVFL,
     *              NMTRTD,MSTOR,(MPRNTB(I),MPRNTS(I),I=1,3)
    77 FORMAT(///,1X,'FROBABLY INCOMPLETE MONTHLY TOTAL (OR MAX*) FOR ',
     *     A4,I5,T72,'OVERFLOW EVENTS:  TYPE A =',I4,', TYPE B =',I4,
     *     ', TYPE C =',I4,
     *     //,1H ,8X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,1X,F7.1,F12.1,'*',
     *     3X,5F8.1,'*',F7.1,'*')
C
C
C
      IF (IPRINT.EQ.2) WRITE(N9,7710) WMONTH(MEND),MRANE,NMRANE,MRUNOF,
     *                   MOVFL,MTRTD,MSTAGE,NMOVFL,NMTRTD,MSTOR,
     *                (MPRNTB(I),MPRNTS(I),I=1,3),MEVNTA,MEVNTB,MEVNTC
  7710 FORMAT (1H ,2X,A4,2X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,1X,F7.1,F12.1,
     *        '*',3X,5F8.1,'*',F7.1,'*',/,T72,'OVERFLOW EVENTS:  TYPE',
     *         ' A =',I4,', TYPE B =',I4,', TYPE C =',I4,/)
C
C                    YEARLY FRINT
C
      IF (IPRINT.EQ.1.OR.IPRINT.EQ.5) GO TO 8010
C
      WRITE(N9,78)  MBEGIN,YBEGIN,MPRES,YPRES,
     *             YEVNTA,YEVNTB,YEVNTC,YRANE,NYRANE,YRUNOF,YOVFL,
     *             YTRTD,YSTAGE,
     *             NYOVFL,NYTRTD,YSTOR,(YFRNTB(I),YFRNTS(I),I=1,3)
    78 FORMAT(///1X,'PROBABLY INCOMPLETE WATER YEAR TOTAL (OR MAX*) FOR',
     *     I3,'/',I3,' - ',I2,'/',I3,T72,'OVERFLOW EVENTS:  TYPE A =',
     *     I4,', TYPE B =',I4,', TYPE C =',I4,/,1X,46('-'),
     *     /,1H ,8X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,
     *     1X,F7.1,F12.1,'*',3X,5F8.1,'*',F7.1,'*')
 8010  CONTINUE
C
      IF (IPRINT .EQ. 1) WRITE(N9,8020) MYRP,YRANE,NYRANE,YRUNOF,YOVFL,
     *                    YTRTD,YSTAGE,NYOVFL,NYTRTD,YSTOR,(YFRNTB(I),
     *                    YFRNTS(I),I=1,3),YEVNTA,YEVNTB,YEVNTC
```

Table A-1 (Contined)

```
 8020 FORMAT( 1H ,2X,I4,2X,F7.2,I6,F9.1,2F9.1,I2,'*',I5,1X,F7.1,F12.1,
     *         '*',3X,5F8.1,'*',F7.1,'*',/,T72,'OVERFLOW EVENTS:  TYPE',
     *         ' A =',I4,', TYPE B =',I4,', TYPE C =',I4,/)
C
C                SUBAREA PRINT
C
      WRITE(N9,79)  REVNTA,REVNTB,REVNTC,RRANE,NRRANE,RRUNOF,ROVFL,
     *              RTRTD,RSTAGE,
     *              NROVFL,NRTRTD,RSTOR,(RPRNTB(I),RPRNTS(I),I=1,3)
   79 FORMAT(///,1H ,'SUBAREA RUN TOTAL (OR MAX*)',T72,
     *  'OVERFLOW EVENTS:  TYPE A =',I4,', TYPE B =',I4,', TYPE C =',I4,
     *  /,1X,26('-'),
     *   /,1H ,8X,F7.2,I6,F9.1,2F9.1,I2,
     *  '*',I5,1X,F7.1,F12.1,'*',3X,4F8.1,F8.1,'*',F7.1,'*')
C
C          CALCULATE STATISTICS FOR MASS BALANCE TABLE
C          AN INITIAL 'P' REFERS TO PERCENTAGES
C
C          PERCENTAGES OF FLOW
C
      IF (RINF .EQ. 0.0)  GO TO 930
        PROF   = 100.0*RRUNOF/RINF
        PDWF   = 100.0*RDWF/RINF
        PLIF   = 100.0*RLIF/RINF
        PTRF   = 100.0*RTRTD/RINF
        POFF   = 100.0*ROVFL/RINF
        PSTORF = 100.0*HSTOR/RINF
      GO TO 940
  930   PROF   = 0.0
        PDWF   = 0.0
        PLIF   = 0.0
        PTRF   = 0.0
        POFF   = 0.0
        PSTORF = 0.0
  940   RRMB = RINB - RTRB - ROFB - HSTORB
        RRMS = RINS - RTRS - ROFS - HSTORS
C
C          PERCENTAGES OF BOD LOAD
C
      IF (RINB .EQ. 0.0)  GO TO 950
        PROB   = 100.0*RROB/RINB
        PDWB   = 100.0*RDWB/RINB
        PLIB   = 100.0*RLIB/RINB
        PTRB   = 100.0*RTRB/RINB
        POFB   = 100.0*ROFB/RINB
        PSTORB = 100.0*HSTORB/RINB
        PRMB   = 100.0*RRMB/RINB
      GO TO 960
  950   PROB   = 0.0
        PDWB   = 0.0
        PLIB   = 0.0
        PTRB   = 0.0
        POFB   = 0.0
        PSTORB = 0.0
        PRMB   = 0.0
C
C          PERCENTAGES OF SS LOAD
C
  960 IF (RINS .EQ. 0.0)  GO TO 970
        PROS   = 100.0*RROS/RINS
```

Table A-1 (Concluded)

```
      PDWS   = 100.0*RDWS/RINS                                          HOUR1154
      PLIS   = 100.0*RLIS/RINS                                          HOUR1155
      PTRS   = 100.0*RTRS/RINS                                          HOUR1156
      POFS   = 100.0*ROFS/RINS                                          HOUR1157
      PSTORS = 100.0*HSTORS/RINS                                        HOUR1158
      PRMS   = 100.0*RRMS/RINS                                          HOUR1159
      GO TO 980                                                         HOUR1160
  970 PROS   = 0.0                                                      HOUR1161
      PDWS   = 0.0                                                      HOUR1162
      PLIS   = 0.0                                                      HOUR1163
      PTRS   = 0.0                                                      HOUR1164
      POFS   = 0.0                                                      HOUR1165
      PSTORS = 0.0                                                      HOUR1166
      PRMS   = 0.0                                                      HOUR1167
C                                                                       HOUR1168
C       WRITE MASS BALANCE TABLE                                        HOUR1169
C                                                                       HOUR1170
  980 WRITE(N9,76) RROB,PROB,RROS,PROS,RRUNOF,PROF,RDWB,PDWB,RDWS,PDWS, HOUR1171
     *             RDWF,PDWF,RLIB,PLIB,RLIS,PLIS,RLIF,PLIF,             HOUR1172
     *             RINB,RINS,RINF,RTRB,PTRB,RTRS,PTRS,RTRTD,PTRF,       HOUR1173
     *             ROFB,POFB,ROFS,POFS,ROVFL,POFF,HSTORB,PSTORB,        HOUR1174
     *             HSTORS,PSTORS,HSTOR,PSTORF,RRMB,PRMB,RRMS,PRMS,      HOUR1175
     *             MDATAP,DDATAP,YDATAP,KDAYS                           HOUR1176
   76 FORMAT(1H1,///,1X,'MASS BALANCES FOR SUBAREA RUN:',/,1H+,30('_'), HOUR1177
     *        //,1H ,50X,'BOD',12X,'SS',11X,'FLOW',                     HOUR1178
     *         /,1H ,46X,11('-'),3X,11('-'),3X,11('-'),                 HOUR1179
     *         /,42X,2('      KLB    %'),'      MGAL    %',             HOUR1180
     *         /,44X,3('   ----- -----'),                               HOUR1181
     *        //,30X,'TOTAL RUNOFF  ',3(F8.0,F6.1),                     HOUR1182
     *         /,30X,'TOTAL DW FLOW ',3(F8.0,F6.1),                     HOUR1183
     *         /,30X,'TOTAL LAT.INFL',3(F8.0,F6.1),                     HOUR1184
     *         /,30X,'TOTAL INFLOW  ',3(F8.0,' 100.0'),                 HOUR1185
     *         /,30X,'TOTAL TREATED ',3(F8.0,F6.1),                     HOUR1186
     *         /,30X,'TOTAL OVERFLOW',3(F8.0,F6.1),                     HOUR1187
     *         /,30X,'FINAL STORAGE ',3(F8.0,F6.1),                     HOUR1188
     *         /,30X,'TOTAL REMOVED ',2(F8.0,F6.1),2X,'NEGLIGIBLE',     HOUR1189
     *     /////,1H0,5X,'DATE OF LAST RAIN DATA CARD IS ',2(I2,'/'),I3, HOUR1190
     *       ///,1H0,5X,'TOTAL NO. DAYS SIMULATED =',I6)                HOUR1191
  990 WRITE(N9,65)                                                      HOUR1192
   65 FORMAT(1H1)                                                       HOUR1193
90909 RETURN                                                            HOUR1194
C***** END SUBROUTINE                                                   HOUR1195
      END                                                               HOUR1196
```

Table A-2. EPAMAC MAIN PROGRAM SEGMENT VARIABLES LIST

Variable Name	Index*	Description	Unit
AKOVER	I,O	Override runoff coefficient (if nonzero)	--
AREA	I,O	Land use area	acres
AUSE	I,O	Land use name	--
BCONC	I,C,O	BOD concentrations for 1st, 2nd, and subsequent hours runoff	mg/L
CLIENT	I,O	Name of agency program is being run for	--
COEFO	O	Weighted average runoff coefficient	--
COEFX	C	Runoff coefficient	--
COEFY	O	Final governing runoff coefficient	--
DWBPK	O	Dry weather peak hourly BOD loading	klb/h
DWBPKD	O	Dry weather peak BOD loading x 24 hr Maximum dry weather daily BOD loading	klb/d
DWBT	O	Dry weather BOD total (24 hr)	klb/h·24 klb/d
DWF	I,C,O	Dry weather hourly flow (24 hr)	Mgal/h
DWFB	I,C,O	Dry weather hourly BOD loads (24 hr)	klb/h
DWFBC	O	Dry weather hourly BOD concentrations (24 hr)	mg/L
DWFPK	O	Dry weather peak hourly flow	Mgal/h
DWFPKD	O	Dry weather peak hourly flow x 24 hr, Maximum dry weather daily flow rate	Mgal/d
DWFS	I,C,O	Dry weather hourly SS load (24 hr)	klb/h
DWFSC	O	Dry weather hourly SS concentration (24 hr)	mg/L
DWFT	O	Dry weather flow total (24 hr)	Mgal/24 h Mgal/d
DWSPK	O	Dry weather peak hourly SS loading	klb/h
DWSPKD	O	Dry weather peak SS loading x 24 hr, Maximum dry weather daily SS loading	klb/d
DWST	O	Dry weather SS total (24 hr)	klb/h·24 klb/d
DWTRT	I,O	Dry weather treatment capacity	Mgal/d
DWTRTH	O	Dry weather daily treatment rate ÷ 24, Hourly dry weather treatment rate	Mgal/h
FREQ	C,O	Frequency title for run	--
FREQS		All frequency titles	--
HOURLY		Subroutine which executes calculations on hourly time basis	--

Table A-2 (Continued)

Variable Name	Index*	Description	Unit
I		Do loop counter	--
I1	O	Pump stage for printout	--
IHR	O	Hour of day for dry weather variable table	--
II		DO loop counter in pump stage determination	--
IPRINT	I,C	Output print control subarea, yearly, monthly, daily, hourly	--
IQL1	C	Quality print option for Column 1 of output pollutants	--
IQL2	C	Quality print option for Column 2 of output pollutants	--
IQL3	C	Quality print option for Column 3 of output pollutants	--
IQL1P	O	Printed value of quality print option for Column 1 (IQL1)	--
IQL2P	O	Printed value of quality print option for Column 2 (IQL2)	--
IQL3P	O	Printed value of quality print option for Column 3 (IQL3)	--
IQUAL	C	BOD & SS quality print option for output	--
ITREAT	I,C,O	Treatment option	--
J		Do loop counter	--
K		Do loop counter	--
L		Do loop counter	--
MODE	I,C,O	Storage operation option (0, 1, 2)	--
MODE1		Temporary record of mode index	--
MODES	O	Storage operation option titles	--
MOVSEP	I,C,O	Minimum type C overflow event separation	h
MRODRY	I,C,O	Minimum dry period for runoff event definition	h
MSTDRY	I,C,O	Minimum dry period for storage operation calculations (mode = 1)	h
MWTYR	I,C,O	Beginning month of water year	mo
N1	I,C,O	Unit assignment for 1st lateral inflow file	--
N2	I,C,O	Unit assignment for 2nd lateral inflow file	--
N3	I,C,O	Unit assignment for 3rd lateral inflow file	--
N4	I,C,O	Unit assignment for 4th lateral inflow file	--
N5	I,C,O	Unit assignment for rain input file (NIN override for each subarea in run)	--
N6	I,C,O	Unit assignment for storage withdrawal output file	--
N7	I,C,O	Unit assignment for storage overflow output file	--
N8	C	Unit assignment for input deck (input device)	--
N9	C	Unit assignment for printout (output device)	--
NIN	O	Unit assignment for rain input file (whole run)	--

Table A-2 (Concluded)

Variable Name	Index*	Description	Unit
NINP		Temporary rain input file record	--
NSUB	O	Do loop counter for subarea calculations	--
NSUBS	I	Number of subareas	--
NTRAV	I,C,O	Lateral inflow travel delays	hr
PUMP	C,O	Total withdrawal rate for various pump stages	Mgal/d
QOPT	C,O	Quality print option titles	--
RAINMN	I,C,O	Minimum rainfall to reset pollutant concentrations in surface runoff	in.
REMTRB	I,C,O	BOD removal efficiency(if ITREAT = 1)	%
REMTRS	I,C,O	SS removal efficiency (if ITREAT = 1)	%
REMSTB	I,C,O	BOD removal efficiency from storage	%
REMSTS	I,C,O	SS removal efficiency from storage	%
RFAC	I,C,O	Rain factor (multiplier for input rain file)	--
ROK	I,O	Land use runoff coefficients	--
SARE	O	Sum of land use areas	acres
SAXRO		Sum of area times runoff coefficients	acres
SCONC	I,C,O	SS concentrations for 1st, 2nd, and subsequent hours of runoff	mg/L
STCRIT	I,C,O	Critical storage capacity (storage operational mode = 1)	Mgal
STMAX	C,O	Maximum storage capacity	Mgal
TRBC	C,O	BOD effluent concentration (if ITREAT = 2)	mg/L
TRSC	C,O	SS effluent concentration (if ITREAT = 2)	mg/L
VOLOFF	I,C,O	Pump OFF switch (storage operation mode = 2)	Mgal
VOLON	I,C,O	Pump ON switch (storage operation mode = 2)	Mgal
WASHED	I,C,O	Watershed name	--
WNAME	I,C,O	Alternate watershed name	--
WPUMP	I,O	Pumped withdrawal rate of wet weather pumps at each stage	Mgal/d

* I = Input variable

C = Common variable

O = Output variable

Table A-3. EPAMAC HOURLY SUBROUTINE VARIABLES LIST

Variable name	Index*	Description	Unit
BCONC	C	BOD concentrations for 1st, 2nd, and subsequent hours runoff	mg/L
CCOUNT		Type C overflow hour counter	--
COEFX	C	Runoff coefficient	--
CTRIGR		Trigger signaling conditions to begin next Type C overflow event	--
DDATA	I,O	Calendar day of current rain data	d
DDATA1	I,O	Calendar day of current lateral inflow No. 1	d
DDATA2	I,O	Calendar day of current lateral inflow No. 2	d
DDATA3	I,O	Calendar day of current lateral inflow No. 3	d
DDATA4	I,O	Calendar day of current lateral inflow No. 4	d
DDATAP	O	Calendar day of previous rain data	d
DOVFL	O	Overflow occurring on current day	Mgal
DPRES	O	Current calendar day of program clock	day
DPRNTB	O	Total daily BOD load or concentration for print output	klb/d or mg/L
DPRNTS	O	Total daily SS load or concentration for print output	klb/d or mg/L
DRANE	O	Total calculated rainfall for current day	in.
DRUNOF	O	Total daily runoff volume	Mgal
DSTAGE	O	Maximum pump stage in day	--
DSTOR	O	Maximum storage level reached in day	Mgal
DTRTD	O	Total daily treated volume	Mgal
DWF	C	Dry weather hourly flow	Mgal/h
DWFB	C	Dry weather hourly BOD loads	klb/h
DWFS	C	Dry weather hourly SS loads	klb/h
FREQ	C,O	Frequency title for run	--
HBOD1	I	BOD load from lateral inflow No. 1	klb/h
HBOD2	I	BOD load from lateral inflow No. 2	klb/h
HBOD3	I	BOD load from lateral inflow No. 3	klb/h
HBOD4	I	BOD load from lateral inflow No. 4	klb/h
HBSAV1		Temporary BOD load from lateral inflow No. 1 shifted by time delay	klb/h
HBSAV2		Temporary BOD load from lateral inflow No. 2 shifted by time delay	klb/h
HBSAV3		Temporary BOD load from lateral inflow No. 3 shifted by time delay	klb/h
HBSAV4		Temporary BOD load from lateral inflow No. 4 shifted by time delay	klb/h

Table A-3 (Continued)

Variable name	Index*	Description	Unit
HDWB		Dry-weather BOD load for current hour	klb/h
HDWF		Dry-weather flow for current hour	Mgal/h
HDWS		Dry weather SS load for current hour	klb/h
HFLO1	I	Flow from lateral inflow No. 1	Mgal/h
HFLO2	I	Flow from lateral inflow No. 2	Mgal/h
HFLO3	I	Flow from lateral inflow No. 3	Mgal/h
HFLO4	I	Flow from lateral inflow No. 4	Mgal/h
HINB		Total BOD load from runoff, dry weather flow, and lateral flow for current hour	klb/h
HINB1		Delay adjusted BOD load from lateral inflow No. 1	klb/h
HINB2		Delay adjusted BOD load from lateral inflow No. 2	klb/h
HINB3		Delay adjusted BOD load from lateral inflow No. 3	klb/h
HINB4		Delay adjusted BOD load from lateral inflow No. 4	klb/h
HINF		Total flow from runoff, dry weather flow and lateral inflow for current hour	Mgal/h
HINQ1		Delay adjusted flow from lateral inflow No. 1	Mgal/h
HINQ2		Delay adjusted flow from lateral inflow No. 2	Mgal/h
HINQ3		Delay adjusted flow from lateral inflow No. 3	Mgal/h
HINQ4		Delay adjusted flow from lateral inflow No. 4	Mgal/h
HINS		Total SS load from runoff, dry weather flow, and lateral inflow for current hour	klb/h
HINS1		Delay adjusted SS load from lateral inflow No. 1	klb/h
HINS2		Delay adjusted SS load from lateral inflow No. 2	klb/h
HINS3		Delay adjusted SS load from lateral inflow No. 3	klb/h
HINS4		Delay adjusted SS load from lateral inflow No. 4	klb/h
HLIB		Total BOD load from all lateral inflows for current hour	klb/h
HLIF		Total flow from all lateral inflows for current hour	Mgal/h
HLIS		Total SS load from all lateral inflows for current hour	klb/h
HOFB		Total BOD load in overflow for current hour	klb/h

Table A-3 (Continued)

Variable name	Index*	Description	Unit
HOFS		Total SS load in overflow for current hour	klb/h
HOURLY		Name of subroutine	--
HOVFL	O	Quantity of overflow in current hour	Mgal/h
HPRES	O	Current hour of program clock	h
HPRNTB	O	Hourly BOD load or concentration for print output	klb/h or mg/L
HPRNTS	O	Hourly SS load or concentration for print output	klb/h or mg/L
HPUMP		Quantity of flow removed by pumping for current hour	Mgal
HQSAV1		Temporary flow from lateral inflow No. 1 shifted by time delay	Mgal/h
HQSAV2		Temporary flow from lateral inflow No. 2 shifted by time delay	Mgal/h
HQSAV3		Temporary flow from lateral inflow No. 3 shifted by time delay	Mgal/h
HQSAV4		Temporary flow from lateral inflow No. 4 shifted by time delay	Mgal/h
HRANE	O	Calculated rain of all for current hour (input rain x multiplier RFAC)	in.
HROB		Total BOD load in runoff for current hour	klb/h
HROS		Total SS load in runoff for current hour	klb/h
HRUNOF	O	Total quantity of runoff for current hour	Mgal/h
HSS1	I	SS load from lateral inflow No. 1	klb/h
HSS2	I	SS load from lateral inflow No. 2	klb/h
HSS3	I	SS load from lateral inflow No. 3	klb/h
HSS4	I	SS load from lateral inflow No. 4	klb/h
HSSAV1		Temporary SS load from lateral inflow No. 1 shifted by time delay	klb/h
HSSAV2		Temporary SS load from lateral inflow No. 2 shifted by time delay	klb/h
HSSAV3		Temporary SS load from lateral inflow No. 3 shifted by time delay	klb/h
HSSAV4		Temporary SS load from lateral inflow No. 4 shifted by time delay	klb/h
HSTAGE	O	Pump stage level required for current hour	--
HSTOR	O	Total storage required for current hour (total volume in current hour to be allocated to storage and overflow)	Mgal
HSTORB	O	BOD load in storage for current hour	klb/h
HSTORS	O	SS load in storage for current hour	klb/h
HTRB		BOD load in treated effluent	klb or mg/L
HTRS		SS load in treated effluent	klb or mg/L
HTRTD	O	Quantity of treated effluent flow	Mgal/h

Table A-3 (Continued)

Variable name	Index*	Description	Unit
I		DO loop counter	--
IGAP		Index for skipping gaps in calendar days without rainfall	--
IHEADG		Print control data for days and hours with no rain, storage, or treatment	--
IPRE		Temporary pump stage index	--
IPREV		Pump stage index from previous hours' pumping	--
IPRINT	C	Print control subarea, yearly, monthly, daily, or hourly	--
IQL		Temporary index for quality print options	--
IQL1	C	Quality print option for column 1 of output pollutants	--
IQL2	C	Quality print option for column 2 of output pollutants	--
IQL3	C	Quality print option for column 3 of output pollutants	--
IQUAL	C	BOD and SS quality print option for output	--
ITREAT	C	Treatment option	--
J		DO loop counter	--
KDAYS	O	Total simulated days counter	--
KSTAGE		Control for Type B event counter	--
L		DO loop counter	--
MBEGIN	O	Beginning month of current water year	mo
MDATA	I,O	Calendar month of current rain data	mo
MDATA1	I,O	Calendar month of current lateral inflow No. 1 data	mo
MDATA2	I,O	Calendar month of current lateral inflow No. 2 data	mo
MDATA3	I,O	Calendar month of current lateral inflow No. 3 data	mo
MDATA4	I,O	Calendar month of current lateral inflow No. 4 data	mo
MDATAP	O	Calendar month of previous rain data	mo
MDRY		Counter of days without runoff, dry days	--
MEND	O	Last calendar month of current water year	mo
MEVNTA	O	Total number of Type A overflow events in current month	--
MEVNTB	O	Total number of Type B overflow events in current month	--
MEVNTC	O	Total number of Type C overflow events in current month	--
MHEADG		Print control for months with no rain, storage or treatment	--

Table A-3 (Continued)

Variable name	Index*	Description	Unit
MODE	C	Storage operation option 0, 1, 2	--
MOVFL	O	Total overflow volume during current month	Mgal
MOVSEP	C,O	Minimum Type C overflow event separation	h
MPRES	O	Current calendar month of program clock	mo
MPREV		Flag for when rain exceeds RAINMN in.	--
MPRNTB	O	Total BOD load or maximum BOD concentration in month for print output	klb or mg/L
MPRNTS	O	Total SS load or maximum SS concentration in month for print output	klb or mg/L
MRANE	O	Total calculated rainfall for current month	in.
MRODRY	C	Minimum dry period for runoff event definition	h
MRUNOF	O	Total runoff volume for current month	Mgal
MSTAGE	O	Maximum pump stage in current month	--
MSTART		Flag for beginning of runoff event	--
MSTDRY	C	Minimum dry period for storage operation calculations (MODE=1)	--
MSTOR	O	Maximum storage volume in current month	Mgal
MSUB		Counter for number of hours since runoff event began (used to determine runoff quality)	--
MTRTD	O	Total treated effluent volume for current month	Mgal
MWET		Counter of days with runoff, wet days	--
MYTYR	C	Beginning month of water year	mo
MYR	O	Date of current year (1900+YPRES)	yr
MYRP	O	Date of previous year	yr
N1	C	Unit assignment for 1st lateral inflow file	--
N2	C	Unit assignment for 2nd lateral inflow file	--
N3	C	Unit assignment for 3rd lateral inflow file	--
N4	C	Unit assignment for 4th lateral inflow file	--
N5	C	Unit assignment for rain input file	--
N6	C	Unit assignment for storage withdrawal output file	--
N7	C	Unit assignment for storage overflow output file	--
N8	C	Unit assignment for input deck (input device)	--
N9	C	Unit assignment for printout (output device)	--
NDELAY		Travel delay for each subsequent lateral inflow	h

Table A-3 (Continued)

Variable name	Index*	Description	Unit
NDELY1		NDELAY+1 temporary time dealy shift	h
NDOVFL	O	Number of voerflow hours in current day	h
NDPM		Number of days per month DATA statement	--
NDRANE	O	Number of rain hours in current day	in.
NDRY		Dry storage hour counter	--
NDTRTD	O	Number of overflow hours in current day	h
NHOVFL	O	Number of overflow hours in current hour (0,1)	h
NHOVFP		Number of overflow hours in previous hour (0,1)	h
NHRANE	O	Number of rain hours in current hour	h
NHTRTD	O	Number of treated hours in current hour (0,1)	h
NMOVFL	O	Number of overflow hours in current month	h
NMRANE	O	Number of rain hours in current month	h
NMTRTD	O	Number of treated hours in current month	h
NROVFL	O	Number of overflow hours in current subarea	h
NRRANE	O	Number of rain hours in current subarea	h
NRTRTD	O	Number of treated hours in current subarea	h
NTRAV	C	Lateral inflow travel delays	h
NYOVFL	O	Number of overflow hours in current year	h
NYRANE	O	Number of rain hours in current year	h
NYTRTD	O	Number of treated hours in current year	h
OVB24	O	BOD load in overflow hourly	klb/h
OVF24	O	Overflow volume hourly	Mgal/h
OVS24	O	SS load in overflow hourly	klb/h
PDWB	O	Dry-weather BOD loading percentage of total BOD load	--
PDWF	O	Dry-weather flow percentage of total inflow	--
PDWS	O	Dry-weather SS loading percentage of total SS load	--
PLIB	O	Lateral inflow BOD loading percentage of total BOD load	--
PLIF	O	Lateral inflow percentage of total inflow	--
PLIS	O	Lateral inflow SS load percentage of total SS load	--
POFB	O	Overflow BOD load percentage of total BOD load	--
POFF	O	Overflow percentage of total flow	--
POFS	O	Overflow SS load percentage of total SS load	--
PRMB	O	BOD load removed percentage of total BOD load	--

Table A-3 (Continued)

Variable name	Index*	Description	Unit
PRMS	O	SS load removed percentage of total SS load	--
PROB	O	Runoff BOD load percentage of total BOD load	--
PROF	O	Runoff percentage of total inflow	--
PROS	O	Runoff SS load percentage of total SS load	--
PSTORB	O	Final storage BOD load percentage of total BOD load	--
PSTORF	O	Final storage volume percentage of total flow	--
PSTORS	O	Final storage SS load percentage of total SS load	--
PTRB	O	Treated BOD load percentage of total BOD load	--
PTRF	O	Treated flow percentage of total flow	--
PTRS	O	Treated SS load percentage of total SS load	--
PUMP	C	Total withdrawl rate for various pump stages	Mgal/d
QOPT	C(QOPTS)	Quality print option titles	--
QQCB		BOD effluent concentration to load conversion	klb/Mgal-h
QQCS		SS effluent concentration to load conversion	klb/Mgal-h
RAIN	I	Input rain data	in.
RAINMN	C	Minimum rainfall to reset pollutant concentrations in surface runoff	in.
RB		BOD load in storage	klb/Mgal-h
RDWB	O	Total dry-weather BOD load for current subarea	klb
RDWF	O	Total dry-weather flow for current subarea	Mgal
RDWS	O	Total dry-weather SS load for current subarea	klb
REMTRB	C	BOD removal efficiency	%
REMTRS	C	SS removal efficiency	%
REMSTB	C	BOD removal efficiency from storage	%
REMSTS	C	SS removal efficiency from storage	%
REVNTA	O	Total number of Type A overflow events in subarea	--
REVNTB	O	Total number of Type B overflow events in subarea	--
REVNTC	O	Total number of Type C overflow events in subarea	--
RFAC	C	Rain factor (multiplier for input rainfile)	--

Table A-3 (Continued)

Variable name	Index*	Description	Unit
RINB	O	Total BOD load from runoff dry-weather (DW) and lateral inflows for current subarea	klb
RINF	O	Total flow from runoff, overflow, and lateral inflows for current subarea	Mgal
RINS	O	Total SS load from runoff, DW flow, and lateral inflows for current subarea	klb
RLIB	O	Total BOD load from lateral inflows for current subarea	klb
RLIF	O	Total flow from lateral inflows for current subarea	Mgal
RLIS	O	Total SS load from lateral inflows for current subarea	klb
ROFB	O	Total BOD overflow for current subarea	klb
ROFS	O	Total SS load in overflow for current subarea	klb
ROVFL	O	Total overflow for current subarea	Mgal
RPRNTB	O	Total BOD load or maximum concentration for subarea for printout	klb or mg/L
RPRNTS	O	Total SS load or maximum concentration for subarea for printout	klb or mg/L
RRANE	O	Total calculated rainfall for current subarea	inches
RRMB	O	Removed BOD loading for subarea	klb
RRMS	O	Removed SS loading for subarea	klb
RROB	O	Total BOD loading in runoff for current subarea	klb
RROS	O	Total SS loading in runoff for current subarea	klb
RRUNOF	O	Total runoff for current subarea	Mgal
RS		SS load in storage	--
RSTAGE	O	Maximum pump stage in current subarea	--
RSTOR	O	Maximum storage volume in current subarea	--
RTRB	O	Total BOD load in treated effluent for current subarea	klb
RTRS	O	Total SS load in treated effluent for current subarea	klb
RTRTD	O	Total treated effluent volume	Mgal/hr
SCONC	C	SS concentrations for 1st, 2nd, and subsequent hours of runoff	mg/L
STCRIT	C	Critical storage capacity (below which pumps remain off)	Mgal
STMAX	C	Maximum storage capacity (storage operational MODE=1)	Mgal
STORA		Total storage volume required during hour (to be allocated)	Mgal
STORAP		Previous hours actual storage	Mgal

Table A-3 (Continued)

Variable name	Index*	Description	Unit
STORB		Remaining storage requirement at various pumping rates (MODE=2)	Mgal
STORBA		Total BOD load in STORA during hour	klb
STOROV		Overflow from storage	Mgal
STORSA		Total SS load in STORA during hour	klb
TRB24	O	BOD load in treated effluent hourly	klb/h
TRBC	C	BOD effluent concentration (if ITREAT=2)	mg/L
TRD24	O	Treated effluent flow hourly	Mgal/h
TRS24	O	SS load in treated effluent hourly	klb/h
TRSC	C	SS effluent concentration (if ITREAT=2)	mg/L
VOLOFF	C	Pump OFF switch	Mgal
VOLON	C	Pump ON switch	Mgal
WASHED	C	Watershed name	--
WMONTH	O	Month title DATA statement	--
WNAME	C	Alternate watershed name	--
YBEGIN	O	Beginning year of current water year	yr
YDATA	I,O	Calendar year of current rain data	yr
YDATA1	I,O	Calendar year of current lateral inflow No. 1	yr
YDATA2	I,O	Calendar year of current lateral inflow No. 2	yr
YDATA3	I,O	Calendar year of current lateral inflow No. 3	yr
YDATA4	I,O	Calendar year of current lateral inflow No. 4	yr
YDATAP	O	Calendar year of previous rain data	yr
YEND	O	Last calendar year of water year	yr
YEVNTA	O	Total number of Type A overflow events in current year	--
YEVNTB	O	Total number of Type B overflow events in current year	--
YEVNTC	O	Total number of Type C overflow events in current year	--
YHEADG		Print control for number of years printed per page of output	--
YOVFL	O	Total overflow volume during current year	Mgal
YPRES	O	Current calendar year of program clock	yr
YPRNTB	O	Total BOD load or maximum BOD concentration in year for print output	klb or mg/L
YPRNTS	O	Total SS load or maximum SS concentration in year for print output	klb or mg/L
YRANE	O	Total calculated rainfall in current year	in.
YRUNOF	O	Total runoff volume in current year	Mgal

Table A-3 (Concluded)

Variable name	Index*	Description	Unit
YSTAGE	O	Maximum pump stage in current year	--
YSTOR	O	Maximum storage volume in current year	Mgal
YTRTD	O	Total treated effluent volume for current year	Mgal

* NOTE: I = Input variable
C = Common variable
O = Output variable

Table A-4. HISTO PROGRAM LISTING

```
C      ************************************************
C        MAC MODEL       VERSION=EPAMAC1       08/15/80
C
C                        HISTO PROGRAM
C
C                       EPA  APPLICATION
C
C      ************************************************
C      DEVELOPER: WILLIAM G. SMITH
C                 METCALF & EDDY, INC., ENGINEERS
C                 P.O. BOX 10-046
C                 1029 CORPORATION WAY
C                 PALO ALTO, CALIF. 94303
C                    TEL:  415/964-7100
C      ************************************************
C
C      THIS COMPUTER PROGRAM WAS DEVELOPED BY METCALF & EDDY, INC.,
C      AND REFINED IN CONNECTION WITH THE SAN FRANCISCO SOUTHWEST
C      WPCP PROJECT, DPW ORDER NO.  108,332.  THIS MODEL WAS THEN
C      GENERALIZED AND DOCUMENTED FOR THE U.S. ENVIRONMENTAL
C      PROTECTION AGENCY IN CONNECTION WITH THE DEVELOPMENT OF
C      PLANNING AND DESIGN PRINCIPLES FOR URBAN STORM WATER
C      AND COMBINED SEWER OVERFLOWS TREATMENT CONTROL FACILITIES,
C      CONTRACT NO. 68-03-2877.
C                   ----  JUNE  24, 1981  ----
C
C      ************************************************
C
C=======================================================================
C          MAIN PROGRAM
C
      COMMON/BLK1/A(13),ASTER,BLANK,X(6,4)
      COMMON/BLK2/TITLE1(20),TITLE2(20),TITLE3(20),DATE(5),KDAYS,
     @            KTOT(6),PEAK(6),KUMTOT(6,13),
     @            DSTART,DSTOP,MOSTAR,MOSTOP,ISTART,ISTOP
      COMMON/BLK3/KT(6),KOUNT(6,13),F(6,12),ITAB(6)
      COMMON/BLK4/QMAX(6),L,IYR,MO,IDAY,JOUT(6),NOUT,
     @            A1(5),A2(5),A3(5),A4(5),A5(5),A6(5),A7(5),A8(5),A9(5),
     @            A10(5),A11(5),
     @            B1(5),B2(5),B3(5),B4(5),B5(5),B6(5),B7(5),B8(5),B9(5),
     @            B10(5),B11(5),
     @            C1(5),C2(5),C3(5),C4(5),C5(5),C6(5),C7(5),C8(5),C9(5),
     @            C10(5),C11(5),
     @            D1(5),D2(5),D3(5),D4(5),D5(5),D6(5),D7(5),D8(5),D9(5),
     @            D10(5),D11(5),
     @            E1(5),E2(5),E3(5),E4(5),E5(5),E6(5),E7(5),E8(5),E9(5),
     @            E10(5),E11(5),
     @            Z1(5),Z2(5),Z3(5),Z4(5),Z5(5),Z6(5),Z7(5),Z8(5),Z9(5),
     @            Z10(5),Z11(5),
     @            IPLT(6),IPLOT
      COMMON/BLK5/QLOW(6),TRF(24),TRB(24),TRS(24),KFLAG,ITABLE
      COMMON/BLK6/Q(6,24),QK(6,24),G(100)
      COMMON/BLK7/N5,N6,N8
      INTEGER*2 DSTART,DSTOP,MOSTAR,MOSTOP,ISTART,ISTOP
      INTEGER*2 ITAB
      INTEGER*2 A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,
     @          B1,B2,B3,B4,B5,B6,B7,B8,B9,B10,B11,
     @          C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,
     @          D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11,
     @          E1,E2,E3,E4,E5,E6,E7,E8,E9,E10,E11,
```

Table A-4 (Continued)

```
     @          Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9,Z10,Z11,
     @          IPLT   ,                 IPLOT
      INTEGER*2 KFLAG,ITABLE
C
C     INPUT DATA REQUIREMENTS
C     -----------------------
C
C    CARD
C    GROUP     FORMAT      VARIABLE            DESCRIPTION
C    -----   -----------   --------   ------------------------------------
C
C      1      5I7          JOUT       OUTPUT FILE NUMBER FOR PLOT
C                              (1)    FLOW RATE
C                              (2)    BOD LOAD
C                              (3)    SS LOAD
C                              (4)    BOD CONCENTRATION
C                              (5)    SS CONCENTRATION
C                              (6)    HOURLY OVERFLOW VOLUME
C
C      2      20A4         TITLE1     PROJECT ACCOUNT NUMBER AND DESCRIPT
C
C      3      5A4          DATE       CALENDAR DATE OF RUN
C
C      4      20A4         TITLE2     80 CHARACTER DESCRIPTIVE TITLE
C
C      5      20A4         TITLE3     80 CHARACTER DESCRIPTIVE TITLE
C
C      6     11I7          DSTART     STARTING   DAY OF DESIRED PRINTOUT
C                          MOSTAR     STARTING MONTH OF DESIRED PRINTOUT
C                          ISTART     STARTING YEAR OF DESIRED PRINTOUT
C                          DSTOP      STOPPING  DAY  OF DESIRED PRINTOUT
C                          MOSTOP     STOPPING MONTH OF DESIRED PRINTOUT
C                          ISTOP      STOPPING YEAR OF DESIRED PRINTOUT
C                          ITABLE     FLAG FOR PRINTING TABLES
C                                        =0, SKIP PRINT
C                                        =1, PRINT TABLES
C                          IPLOT      FLAG FOR PLOTTING HISTOGRAMS
C                                        =0, SKIP PLOT
C                                        =1, PLOT HISTOGRAMS
C
C                          (IF ITABLE=0, SKIP CARD 7)
C
C      7      6I7          ITAB       FLAG FOR PRINTING TABLES
C                                        =0, SKIP TABLE
C                                        =1, PRINT TABLE
C                              (1)    FLOW RATE, MGAL/D
C                              (2)    BOD LOAD, LBS/HR
C                              (3)    SS LOAD, LBS/HR
C                              (4)    BOD CONCENTRATION, MG/L
C                              (5)    SS CONCENTRATION, MG/L
C                              (6)    OVERFLOW VOLUME, MGAL/HR
C
C                          (IF ITABLE=0, SKIP CARDS 8)
C                          REPEAT CARD 8 FOR ALL 5 TABLES
C
C      8      10F7.0       F(3)-F(12) RANGE VALUES FOR SUMMARY TABLE
C                          NOTE:  F(3) MUST BE GREATER THAN 10% OF QMAX
C                                 FROM CARD GROUP 16
C
C
```

Table A-4 (Continued)

```
C                             (IF IPLOT=0, SKIP CARD 9)
C
C    9     6I7                IPLT       FLAG FOR PLOTTING HISTOGRAMS
C                                           =0, SKIP PLOT
C                                           =1, PLOT HISTOGRAMS
C                                (1)     FLOW RATE, MGAL/D
C                                (2)     BOD LOAD, LBS/HR
C                                (3)     SS LOAD, LBS/HR
C                                (4)     BOD CONCENTRATION, MG/L
C                                (5)     SS CONCENTRATION, MG/L
C                                (6)     OVERFLOW VOLUME, MGAL/HR
C
C                             (IF IPLOT=0, SKIP CARD GROUPS 10 THRU 14)
C
C   10     11(2X,5A1)         A1-A11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (FLOW RATE, MGAL/D)
C
C   11     11(2X,5A1)         B1-B11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (BOD LOAD, LBS/HR)
C
C   12     11(2X,5A1)         C1-C11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (SS LOAD, LBS/HR)
C
C   13     11(2X,5A1)         D1-D11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (BOD CONC, MG/L)
C
C   14     11(2X,5A1)         E1-E11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (SS CONC, MG/L)
C
C   15     11(2X,5A1)         Z1-Z11     5 DIGIT NUMBERS FOR HORIZ AXIS.
C                                        BEGIN WITH ZERO.  MUST BE RIGHT
C                                        JUSTIFIED.  (OVERFLOW VOLUME,
C                                        MGAL/HR)
C
C   16     6F7.0              QMAX       MAXIMUM VALUE FOR PLOT
C                                (1)     (FLOW RATE, MGAL/D)
C                                (2)     (BOD LOAD, LBS/HR)
C                                (3)     (SS LOAD, LBS/HR)
C                                (4)     (BOD CONCENTRATION, MG/L)
C                                (5)     (SS CONCENTRATION, MG/L)
C                                (6)     (OVERFLOW VOLUME, MGAL/HR)
C
C
C
C
      N5=5
      N6=6
      N8=8
C
C     REWIND INPUT DATA TAPE OR DISK
C
      REWIND N8
C
C     READ NUMBERS FOR OUTPUT FILE FOR PLOTS.  EACH PLOT
C     DESIRED MUST HAVE A SEPARATE NUMBER.  INCLUDE APPROPRIATE
```

Table A-4 (Continued)

```
C         JOB CONTROL LANGUAGE TO IDENTIFY EACH OUTPUT FILE TO
C         DIRECT THE OUTPUT TO THE LINE PRINTER.
C
      READ(N5,510)JOUT
C
C         INITIALIZE VARIABLES
C
      KFLAG=0
      KDAYS=0
      DO 102 I=1,6
      KTOT(I)=0
      KT(I)=0
      PEAK(I)=0.
      QLOW(I)=0.
      DO 104 II=1,24
  104 Q(I,II)=0.
      DO 106 II=1,13
      KUMTOT(I,II)=0
  106 KCOUNT(I,II)=0
  102 F(I,1)=0.
C
C         BEGIN READING INPUT DATA CARDS.
C
      READ(N5,506)TITLE1
      READ(N5,508)DATE
      READ(N5,506)TITLE2
      READ(N5,506)TITLE3
      READ(N5,510)DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP,ITABLE,IPLOT
      IF(MOSTAR.EQ.0.OR.ISTART.EQ.0.OR.MOSTOP.EQ.0.OR.ISTOP.EQ.0)KFLAG=1
      IF(MOSTAR.EQ.0) MOSTAR=13
      IF(MOSTOP.EQ.0) MOSTOP=13
  506 FORMAT(20A4)
  508 FORMAT(5A4)
  510 FORMAT(11I7)
C
C         WRITE HEADER PAGE
C
      WRITE(N6,620)TITLE1,DATE,TITLE2,TITLE3,
     @ DSTART,A(MOSTAR),ISTART,DSTOP,A(MOSTOP),
     @ ISTOP
  620 FORMAT(///////////,T29,92(1H*)/5(T29,1H*,T120,1H*/),T29,1H*,T72,
     @ 7HPROJECT,T120,1H*/T29,1H*,T72,7(1H-),T120,1H*/T29,1H*,5X,20A4,
     @ T120,
     @ 1H*/2(T29,1H*,T120,1H*/),T29,1H*,T74,4HDATE,T120,1H*/T29,1H*,T74,
     @ 4H----,T120,1H*/T29,1H*,T66,5A4,T120,1H*/3(T29,1H*,T120,1H*/),
     @ T29,
     @ 1H*,5X,20A4,T120,1H*/T29,1H*,5X,20A4,T120,1H*/3(T29,1H*,T120,1H*/
     @ ),
     @ T29,1H*,T70,11HFLOW PERIOD,T120,1H*/T29,1H*,T70,12(1H-),T120,1H*/
     @ T29,1H*,T63,I2,A4,3H 19,I2,4H TO ,I2,A4,3H 19,I2,T120,1H*/5(T29,
     @ 1H*,T120,
     @ 1H*/),T29,92(1H*))
C
C         READ VALUES FOR FLOW RANGE SUMMARY TABLE
C         IF ITABLE NOT EQUAL TO ZERO (0) ON CARD GROUP 8
C
      IF(ITABLE.EQ.0) GO TO 108
      READ(N5,510) (ITAB(I),I=1,6)
      DO 110 I=1,6
      READ(N5,512) (F(I,II),II=3,12)
```

Table A-4 (Continued)

```
  512 FORMAT(16F7.0)                                                    MAIN241
  110 CONTINUE                                                          MAIN242
  108 CONTINUE                                                          MAIN243
C                                                                       MAIN244
C         READ NUMBERS FOR HORIZONTAL AXIS OF PLOTS                     MAIN245
C         IF IPLOT NOT EQUAL TO ZERO (0) ON CARD GROUPS 10 TO 16        MAIN246
C                                                                       MAIN247
      IF(IPLOT.EQ.0) GO TO 112                                          MAIN248
      READ(N5,510) (IPLT(I),I=1,6)                                      MAIN249
      READ(N5,502)A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11                    MAIN250
      READ(N5,502)B1,B2,B3,B4,B5,B6,B7,B8,B9,B10,B11                    MAIN251
      READ(N5,502)C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11                    MAIN252
      READ(N5,502)D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11                    MAIN253
      READ(N5,502)E1,E2,E3,E4,E5,E6,E7,E8,E9,E10,E11                    MAIN254
      READ(N5,502)Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9,Z10,Z11                    MAIN255
  502 FORMAT(11(2X,5A1))                                                MAIN256
  112 CONTINUE                                                          MAIN257
C                                                                       MAIN258
C         READ MAXIMUM FLOW VALUE (MGAL/D) ALLOWED (CARD GROUP 16)      MAIN259
C                                                                       MAIN260
      READ(N5,504)(QMAX(I),I=1,6)                                       MAIN261
  504 FORMAT(11F7.0)                                                    MAIN262
C                                                                       MAIN263
C         DETERMINE LOWEST VALUE FOR PLOT                               MAIN264
C                                                                       MAIN265
      DO 114 I=1,6                                                      MAIN266
      QLOW(I)=QMAX(I)/100.                                              MAIN267
  114 F(I,2)=QLOW(I)                                                    MAIN268
C                                                                       MAIN269
C         PRINT OUT ECHO OF INPUT DATA                                  MAIN270
C                                                                       MAIN271
      WRITE(N6,650)TITLE1,DATE,TITLE2,TITLE3,DSTART,MOSTAR,ISTART,DSTOP,MAIN272
     @  MOSTOP,ISTOP                                                    MAIN273
  650 FORMAT(1H1,/////T5,10HINPUT DATA,/T5,10(1H-)//T5,9HTITLE1 : ,20A4,MAIN274
     @ /T5,7HDATE : ,5A4,/T5,9HTITLE2 : ,20A4,/T5,9HTITLE3 : ,20A4,/T5, MAIN275
     @ 9HDSTART : ,I3,5X,                                               MAIN276
     @ 9HMOSTAR : ,I3,5X,9HISTART : ,I3,5X,8HDSTOP : ,I3,5X,9HMOSTOP : ,MAIN277
     @ I3,5X,8HISTOP : ,I3)                                             MAIN278
      WRITE(N6,640) JOUT(1),JOUT(2),JOUT(3),JOUT(4),JOUT(5),JOUT(6)     MAIN279
  640 FORMAT(/T5,17HOUTPUT FILE NO'S:,5X,8HJOUT(1):,I3,4X,              MAIN280
     @ 8HJOUT(2):,I3,4X,8HJOUT(3):,I3,4X,8HJOUT(4):,I3,4X,8HJOUT(5):,   MAIN281
     @ I3,4X,8HJOUT(6):,I3)                                             MAIN282
      WRITE(N6,690)ITABLE                                               MAIN283
  690 FORMAT(/T5,9HITABLE : ,I2)                                        MAIN284
      IF(ITABLE.EQ.1)WRITE(N6,691)(ITAB(I),I=1,6)                       MAIN285
  691 FORMAT(1H+,T30,4HITAB,2X,4H(1):,I2,5X,4H(2):,I2,5X,4H(3):,I2,5X,  MAIN286
     @ 4H(4):,I2,5X,4H(5):,I2,5X,4H(6):,I2)                             MAIN287
      WRITE(N6,692)IPLOT                                                MAIN288
  692 FORMAT(/T5,8HIPLOT : ,I3)                                         MAIN289
      IF(IPLOT.EQ.1)WRITE(N6,693)(IPLT(I),I=1,6)                        MAIN290
  693 FORMAT(1H+,T30,4HIPLT,2X,4H(1):,I2,5X,4H(2):,I2,5X,4H(3):,I2,5X,  MAIN291
     @ 4H(4):,I2,5X,4H(5):,I2,5X,4H(6):,I2)                             MAIN292
      IF(ITABLE.EQ.0) GO TO 814                                         MAIN293
      DO 810 MJ=1,6                                                     MAIN294
      WRITE(N6,694) X(MJ,1),X(MJ,2),X(MJ,3),X(MJ,4),(F(MJ,M),M=3,12)    MAIN295
  694 FORMAT(/T5,A4,1X,A4,15H RANGE VALUES (,2A3,3H) :,T43,10F8.0)      MAIN296
  810 CONTINUE                                                          MAIN297
  814 CONTINUE                                                          MAIN298
      IF(IPLOT.EQ.0) GO TO 812                                          MAIN299
      WRITE(N6,695)X(1,1),X(1,2),A1,A2,A3,A4,A5,A6,A7,A8,A° ^10,A11     MAIN300
      WRITE(N6,695)X(2,1),X(2,2),B1,B2,B3,B4,B5,B6,B7,B8,B9,B10,B11
      WRITE(N6,695)X(3,1),X(3,2),C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11
      WRITE(N6,695)X(4,1),X(4,2),D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11
      WRITE(N6,695)X(5,1),X(5,2),E1,E2,E3,E4,E5,E6,E7,E8,E9,E10,E11
      WRITE(N6,695)X(6,1),X(6,2),Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9,Z10,Z11
  695 FORMAT(/T5,24HHORIZONTAL AXIS LABELS (,A4,1X,A4,3H) :,T43,
     @ 11(3X,5A1))
  812 CONTINUE
      WRITE(N6,696) (QMAX(MJ),MJ=1,6)
  696 FORMAT(/T5,4HQMAX,2X,7H(FLOW):,F7.0,2X,11H(BOD LOAD):,F7.0,2X,
     @ 10H(SS LOAD):,F7.0,2X,11H(BOD CONC):,F7.0,2X,10H(SS CONC):,F7.0,
     @ 2X,11H(OVFL VOL):,F7.3)
      WRITE(N6,698)(QLOW(MJ),MJ=1,6)
  698 FORMAT(/T5,4HQLOW,2X,7H(FLOW):,F7.0,2X,11H(BOD LOAD):,F7.0,2X,
     @ 10H(SS LOAD):,F7.0,2X,11H(BOD CONC):,F7.0,2X,10H(SS CONC):,F7.0,
     @ 2X,11H(OVFL VOL):,F7.3,/1H ,T5,12H(CALCULATED))
C
C          BEGIN LOOP FOR DATA PLOTTING AND TABULATION
C
  100 CONTINUE
C
C          BEGIN DO LOOP FOR EACH PAGE OF PLOTTED OUTPUT - 2 DAYS
C          PER PAGE.  ALSO FOR DATA FOR TABULATIONS.
C
      DO 206 L=1,2
C
C          READ INPUT DATA FILE FROM TAPE OR DISK ONE DAY AT A TIME.
C
      READ(N8,END=999)IYR,MO,IDAY,TRF
     @ ,TRB,TRS
      IF(KFLAG.EQ.0) GO TO 710
      IF(KDAYS.GT.0) GO TO 720
      DSTART=IDAY
      MOSTAR=MO
      ISTART=IYR
      DSTOP=IDAY
      GO TO 219
  720 MOSTOP=MO
      ISTOP=IYR
      GO TO 219
C
C          CHECK TO SEE IF DATA IS WITHIN PERIOD DESIRED FOR PRINTOUT.
C
  710 IF(IYR.LT.ISTART)GO TO 100
      IF(MO.LT.MOSTAR.AND.IYR.EQ.ISTART)GO TO 100
      IF(IDAY.LT.DSTART.AND.MO.EQ.MOSTAR.AND.IYR.EQ.ISTART)GO TO 100
      IF(IYR.GT.ISTOP                  )GO TO 999
      IF(IYR.EQ.ISTOP.AND.MO.GT.MOSTOP             )GO TO 999
      IF(IYR.EQ.ISTOP.AND.MO.EQ.MOSTOP.AND.IDAY.GT.DSTOP) GO TO 999
  219 KDAYS=KDAYS+1
C
C          CALCULATE HOURLY VALUES FOR PLOTS AND TABLES.
C
  220 DO 208 I=1,6
      DO 208 IH=1,24
      GO TO (258,256,254,252,250,2502),I
 2502 Q(I,IH)=TRF(IH)
      IF(Q(I,IH).GT.PEAK(I)) PEAK(I)=Q(I,IH)
      GO TO 208
  250 IF(TRF(IH).EQ.0.) GO TO 290
```

Table A-4 (Continued)

```
      Q(I,IH)=(TRS(IH)*1000.)/(TRF(IH)*8.34)                            MAIN361
      GO TO 292                                                         MAIN362
  290 Q(I,IH)=0.                                                        MAIN363
  292 IF(Q(I,IH).GT.PEAK(I))PEAK(I)=Q(I,IH)                             MAIN364
      GO TO 208                                                         MAIN365
  252 IF(TRF(IH).EQ.0.) GO TO 294                                       MAIN366
      Q(I,IH)=(TRB(IH)*1000.)/(TRF(IH)*8.34)                            MAIN367
      GO TO 296                                                         MAIN368
  294 Q(I,IH)=0.                                                        MAIN369
  296 IF(Q(I,IH).GT.PEAK(I))PEAK(I)=Q(I,IH)                             MAIN370
      GO TO 208                                                         MAIN371
  254 Q(I,IH)= TRS(IH)*1000.                                            MAIN372
      IF(Q(I,IH).GT.PEAK(I))PEAK(I)=Q(I,IH)                             MAIN373
      GO TO 208                                                         MAIN374
  256 Q(I,IH)= TRB(IH)*1000.                                            MAIN375
      IF(Q(I,IH).GT.PEAK(I))PEAK(I)=Q(I,IH)                             MAIN376
      GO TO 208                                                         MAIN377
  258 Q(I,IH)= TRF(IH)*24.                                              MAIN378
      IF(Q(I,IH).GT.PEAK(I))PEAK(I)=Q(I,IH)                             MAIN379
  208 CONTINUE                                                          MAIN380
C                                                                       MAIN381
C          CALL SUBROUTINE RANGES IF TABLES ARE TO BE PRINTED.          MAIN382
C                                                                       MAIN383
      IF(ITABLE.EQ.1) CALL RANGES                                       MAIN384
      IF(IPLOT.EQ.0) GO TO 202                                          MAIN385
C                                                                       MAIN386
C          CHECK FOR FLOW AT ANY TIME DURING DAY.  IF YES, CALL SUB-    MAIN387
C          ROUTINE PLOT.  IF NO FLOW BUT THIS WOULD BE THE SECOND DAY   MAIN388
C          OF A TWO-DAY PLOT, CALL SUBROUTINE PLOT.                     MAIN389
C                                                                       MAIN390
      DO 260 IH=1,24                                                    MAIN391
      IF(Q(1,IH).GT.0.0) GO TO 210                                      MAIN392
C     IF(Q(1,IH)-QLOW(1))260,706,706                                    MAIN393
C 706 GO TO 210                                                         MAIN394
  260 CONTINUE                                                          MAIN395
      IF(L.EQ.2)GO TO 210                                               MAIN396
      GO TO 100                                                         MAIN397
C                                                                       MAIN398
C          BEGIN HOURLY LOOP                                            MAIN399
C                                                                       MAIN400
  210 CALL PLOT                                                         MAIN401
  202 CONTINUE                                                          MAIN402
  206 CONTINUE                                                          MAIN403
      GO TO 100                                                         MAIN404
  999 CONTINUE                                                          MAIN405
C                                                                       MAIN406
C          IF TABLES ARE DESIRED, CALL SUBROUTINE TABLES.               MAIN407
C                                                                       MAIN408
      IF(ITABLE.GT.0)CALL TABLES                                        MAIN409
      STOP                                                              MAIN410
      END                                                               MAIN411
C=======================================================================RANG   1
      SUBROUTINE RANGES                                                 RANG   2
      COMMON/BLK3/KT(6),KOUNT(6,13),F(6,12),ITAB(6)                     RANG   3
      COMMON/BLK6/Q(6,24),QK(6,24),G(100)                               RANG   4
      COMMON/BLK7/N5,N6,N8                                              RANG  4A
      INTEGER*2 ITAB                                                    RANG   5
C                                                                       RANG   6
C          BEGIN DO LOOP TO DETERMINE THE CUMULATIVE HOURS FOR EACH     RANG   7
C          RANGE FOR EACH TABLE.                                        RANG   8
```

Table A-4 (Continued)

```
C
      DO 402 I=1,6                                                      RANG   9
      IF(ITAB(I).EQ.0) GO TO 402                                        RANG  10
      DO 404 IH=1,24                                                    RANG  11
      KT(I)=KT(I)+1                                                     RANG  12
C                                                                       RANG  13
C          CHECK FOR NEGATIVE VALUES.                                   RANG  14
C                                                                       RANG  15
      IF(Q(I,IH))431,432,433                                            RANG  16
C                                                                       RANG  17
C          IF NEGATIVE, WRITE ERROR MESSAGE AND STOP PROGRAM.           RANG  18
C                                                                       RANG  19
  431 WRITE(N6,602)I,IH,Q(I,IH)                                         RANG  20
  602 FORMAT(1H1,T5,'PROGRAM STOPPED BECAUSE Q(I',I1,',',I2,') = ',     RANG  21
     @      F10.2,' (NEGATIVE)')                                        RANG  22
      STOP 431                                                          RANG  23
  432 KOUNT(I,1)=KOUNT(I,1)+1                                           RANG  24
      GO TO 404                                                         RANG  25
  433 DO 430 II=1,11                                                    RANG  26
      IF(Q(I,IH).GT.F(I,II).AND.Q(I,IH).LE.F(I,II+1)) GO TO 435         RANG  27
      GO TO 430                                                         RANG  28
  435 KOUNT(I,II+1)=KOUNT(I,II+1)+1                                     RANG  29
      GO TO 404                                                         RANG  30
  430 CONTINUE                                                          RANG  31
      IF(Q(I,IH).GT.F(I,12)) KOUNT(I,13)=KOUNT(I,13)+1                  RANG  32
  404 CONTINUE                                                          RANG  33
  402 CONTINUE                                                          RANG  34
      RETURN                                                            RANG  35
      END                                                               RANG  36
C=======================================================================RANG  37
      SUBROUTINE TABLES                                                 TABL   1
      COMMON/BLK1/A(13),ASTER,BLANK,X(6,4)                              TABL   2
      COMMON/BLK2/TITLE1(20),TITLE2(20),TITLE3(20),DATE(5),KDAYS,       TABL   3
     @            KTOT(6),PEAK(6),KUMTOT(6,13),                         TABL   4
     @            DSTART,DSTOP,MOSTAR,MOSTOP,ISTART,ISTOP               TABL   5
      COMMON/BLK3/KT(6),KOUNT(6,13),F(6,12),ITAB(6)                     TABL   6
      COMMON/BLK7/N5,N6,N8                                              TABL   7
      INTEGER*2 DSTART,DSTOP,MOSTAR,MOSTOP,ISTART,ISTOP                 TABL   7A
      INTEGER*2 ITAB                                                    TABL   8
      INTEGER*2 DSTART,DSTOP,MOSTAR,MOSTOP,ISTART,ISTOP                 TABL   9
C                                                                       TABL  10
C          BEGIN DO LOOP TO PRINT DESIRED TABLES.                       TABL  11
C                                                                       TABL  12
      DO 200 K=1,6                                                      TABL  13
      IF(ITAB(K).EQ.0) GO TO 200                                        TABL  14
      WRITE(N6,630) TITLE2,TITLE3                                       TABL  15
  630 FORMAT(1H1,/////,T21,15HTITLE       :  ,20A4/,T21,                TABL  16
     @  15H              ,20A4)                                         TABL  17
      DO 102 JJ=1,13                                                    TABL  18
      J=13-JJ+1                                                         TABL  19
      KTOT(K)=KTOT(K)+KOUNT(K,J)                                        TABL  20
  102 KUMTOT(K,J)=KTOT(K)                                               TABL  21
C                                                                       TABL  22
C          WRITE TABLE HEADING                                          TABL  23
C                                                                       TABL  24
      GO TO (310,320,330,340,350,3502),K                                TABL  25
  310 WRITE(N6,652)                                                     TABL  26
      GO TO 360                                                         TABL  27
  320 WRITE(N6,654)                                                     TABL  28
      GO TO 360                                                         TABL  29
                                                                        TABL  30
```

Table A-4 (Continued)

```
  330 WRITE(N6,656)
      GO TO 360
  340 WRITE(N6,658)
      GO TO 360
  350 WRITE(N6,660)
      GO TO 360
 3502 WRITE(N6,6602)
  360 CONTINUE
  652 FORMAT(////,T57,17HFLOW RATE SUMMARY/)
  654 FORMAT(////,T58,16HBOD LOAD SUMMARY/)
  656 FORMAT(////,T51,29HSUSPENDED SOLIDS LOAD SUMMARY/)
  658 FORMAT(////,T53,25HBOD CONCENTRATION SUMMARY/)
  660 FORMAT(////,T47,38HSUSPENDED SOLIDS CONCENTRATION SUMMARY/)
 6602 FORMAT(////,T50,30HHOURLY OVERFLOW VOLUME SUMMARY/)
      WRITE(N6,632)
  632 FORMAT(/,T2,129(1H-),//T104,9HINCREMENT,T121,10HCUMULATIVE/,
     @    T106,6HTOTAL,,T123,6HTOTAL,/,T106,5HHOURS,T123,5HHOURS/,
     @    T104,9(1H-),T121,10(1H-)//)
C
C          WRITE TABLE BODY.
C
      IF(6-K) 101,101,110
  110 WRITE(N6,638)X(K,1),X(K,2),F(K,12),X(K,3),X(K,4),KOUNT(K,13),
     @    KUMTOT(K,13)
  638 FORMAT(T21,A4,1X,A4,14H GREATER THAN ,F6.0,1X,A3,A4,T105,I6,
     @    T123,I6)
      DO 100 II=1,11
      I=11-II+1
      WRITE(N6,636)X(K,1),X(K,2),F(K,I),X(K,3),X(K,4),F(K,I+1),X(K,3),
     @    X(K,4),KOUNT(K,I+1),KUMTOT(K,I+1)
  636 FORMAT(/T21,A4,1X,A4,14H GREATER THAN ,F6.0,1X,A3,A4,
     @    27H BUT LESS THAN OR EQUAL TO ,F6.0,1X,A3,A4,T105,I6,T123,I6)
  100 CONTINUE
      GO TO 220
  101 WRITE(N6,6380)X(K,1),X(K,2),F(K,12),X(K,3),X(K,4),KOUNT(K,13),
     @    KUMTOT(K,13)
 6380 FORMAT(T21,A4,1X,A4,14H GREATER THAN ,F6.3,1X,A3,A4,T105,I6,
     @    T123,I6)
      DO 1000 II=1,11
      I=11-II+1
      WRITE(N6,6360)X(K,1),X(K,2),F(K,I),X(K,3),X(K,4),F(K,I+1),X(K,3),
     @    X(K,4),KOUNT(K,I+1),KUMTOT(K,I+1)
 6360 FORMAT(/T21,A4,1X,A4,14H GREATER THAN ,F6.3,1X,A3,A4,
     @    27H BUT LESS THAN OR EQUAL TO ,F6.3,1X,A3,A4,T105,I6,T123,I6)
 1000 CONTINUE
  220 WRITE(N6,634)X(K,1),X(K,2),F(K,1),X(K,3),X(K,4),KOUNT(K,1),
     @    KUMTOT(K,1)
  634 FORMAT(/T21,A4,1X,A4,16H EQUAL TO ZERO (,F3.1,2H) ,A3,A4,
     @    T105,I6,T123,I6)
      WRITE(N6,640)KT(K)
  640 FORMAT(/T104,9(1H-)/T21,11HTOTAL HOURS,T105,I6,/T2,129(1H-))
C
C          WRITE SUMMARY FO PEAK VALUE, STARTING AND STOPPING DATES,
C          AND TOTAL DAYS OF SIMULATION.
C
      IF(6-K) 240,240,230
  230 WRITE(N6,642)X(K,1),X(K,2),PEAK(K),X(K,3),X(K,4),KDAYS,DSTART,
     @    A(MOSTAR),ISTART,DSTOP,A(MOSTOP),ISTOP
  642 FORMAT(/T21,5HPEAK ,A4,1X,A4,3H = ,F8.1,1X,A3,A4,T63,
     @    13HTOTAL DAYS = ,I5,T91,14HFLOW PERIOD : ,I2,A4,3H 19,I2,
```

Table A-4 (Continued)

```
     @    4H TO ,I2,A4,3H 19,I2)
      GO TO 200
  240 WRITE(N6,6420)X(K,1),X(K,2),PEAK(K),X(K,3),X(K,4),KDAYS,DSTART,
     @    A(MOSTAR),ISTART,DSTOP,A(MOSTOP),ISTOP
 6420 FORMAT(/T21,5HPEAK ,A4,1X,A4,3H = ,F8.3,1X,A3,A4,T63,
     @    13HTOTAL DAYS = ,I5,T91,14HFLOW PERIOD : ,I2,A4,3H 19,I2,
     @    4H TO ,I2,A4,3H 19,I2)
  200 CONTINUE
      RETURN
      END
C=======================================================================
      SUBROUTINE PLOT
      COMMON/BLK1/A(13),ASTER,BLANK,X(6,4)
      COMMON/BLK4/QMAX(6),L,IYR,MO,IDAY,JOUT(6),NOUT,
     @          A1(5),A2(5),A3(5),A4(5),A5(5),A6(5),A7(5),A8(5),A9(5),
     @          A10(5),A11(5),
     @          B1(5),B2(5),B3(5),B4(5),B5(5),B6(5),B7(5),B8(5),B9(5),
     @          B10(5),B11(5),
     @          C1(5),C2(5),C3(5),C4(5),C5(5),C6(5),C7(5),C8(5),C9(5),
     @          C10(5),C11(5),
     @          D1(5),D2(5),D3(5),D4(5),D5(5),D6(5),D7(5),D8(5),D9(5),
     @          D10(5),D11(5),
     @          E1(5),E2(5),E3(5),E4(5),E5(5),E6(5),E7(5),E8(5),E9(5),
     @          E10(5),E11(5),
     @          Z1(5),Z2(5),Z3(5),Z4(5),Z5(5),Z6(5),Z7(5),Z8(5),Z9(5),
     @          Z10(5),Z11(5),
     @          IPLT(6),IPLOT
      COMMON/BLK6/Q(6,24),QK(6,24),G(100)
      COMMON/BLK7/N5,N6,N8
      INTEGER*2 A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,
     @         B1,B2,B3,B4,B5,B6,B7,B8,B9,B10,B11,
     @         C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,
     @         D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11,
     @         E1,E2,E3,E4,E5,E6,E7,E8,E9,E10,E11,
     @         Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9,Z10,Z11,
     @         IPLT    ,               IPLOT
C
C          BEGIN DO LOOP FOR DESIRED PLOTS.
C
      DO 202 I=1,6
C
C          SET APPROPRIATE OUTPUT FILE NUMBER FOR LINE PRINTER.
C
      NOUT=JOUT(I)
      IF(IPLT(I).EQ.0) GO TO 202
      DO 298 IH=1,24
C
C          BEGIN DO LOOP FOR PLOTTING HOURLY VALUES.
C
      DO 204 K=1,100
      IQ=IH-12
      QK(I,IH)=(QMAX(I)*K)/100.
      IF(QK(I,IH).LE.Q(I,IH)) GO TO 302
      G(K)=BLANK
      GO TO 204
  302 G(K)=ASTER
  204 CONTINUE
      IF(L.EQ.1.AND.IH.EQ.1) GO TO 212
      GO TO 214
C
```

Table A-4 (Continued)

```
C         WRITE HEADING FOR PLOTS.
C
  212 GO TO (240,242,244,246,248,2482),I
  240 WRITE(NOUT,602)
  602 FORMAT(1H1,57X,17HFLOW RATE, MGAL/D//)
      DO 102 J=1,5
  102 WRITE(NOUT,604)A1(J),A2(J),A3(J),A4(J),A5(J),A6(J),A7(J),
     @               A8(J),A9(J),A10(J),A11(J)
  604 FORMAT(1H ,16X,A1,10(9X,A1))
      GO TO 250
  242 WRITE(NOUT,620)
  620 FORMAT(1H1,58X,16HBOD LOAD, LBS/HR//)
      DO 104 J=1,5
  104 WRITE(NOUT,604)B1(J),B2(J),B3(J),B4(J),B5(J),B6(J),B7(J),
     @               B8(J),B9(J),B10(J),B11(J)
      GO TO 250
  244 WRITE(NOUT,622)
  622 FORMAT(1H1,49X,34HSUSPENDED SOLIDS (SS) LOAD, LBS/HR//)
      DO 106 J=1,5
  106 WRITE(NOUT,604)C1(J),C2(J),C3(J),C4(J),C5(J),C6(J),C7(J),
     @               C8(J),C9(J),C10(J),C11(J)
      GO TO 250
  246 WRITE(NOUT,624)
  624 FORMAT(1H1,55X,23HBOD CONCENTRATION, MG/L//)
      DO 108 J=1,5
  108 WRITE(NOUT,604)D1(J),D2(J),D3(J),D4(J),D5(J),D6(J),D7(J),
     @               D8(J),D9(J),D10(J),D11(J)
      GO TO 250
  248 WRITE(NOUT,626)
  626 FORMAT(1H1,46X,41HSUSPENDED SOLIDS (SS) CONCENTRATION, MG/L//)
      DO 110 J=1,5
  110 WRITE(NOUT,604)E1(J),E2(J),E3(J),E4(J),E5(J),E6(J),E7(J),
     @               E8(J),E9(J),E10(J),E11(J)
      GO TO 250
 2482 WRITE(NOUT,6262)
 6262 FORMAT(1H1,51X,31HHOURLY OVERFLOW VOLUME, MGAL/HR//)
      DO 1102 J=1,5
 1102 WRITE(NOUT,604)Z1(J),Z2(J),Z3(J),Z4(J),Z5(J),Z6(J),Z7(J),
     @               Z8(J),Z9(J),Z10(J),Z11(J)
  250 CONTINUE
  252 WRITE(NOUT,606)
  606 FORMAT(1H /,1H ,16X,1HM,10(10H.........I))
  262 CONTINUE
C
C         PRINT OUT PLOTS.
C
  214 IF(IH.NE.12.AND.IH.NE.24) GO TO 306
      IF(IH.NE.12) GO TO 304
C
C         WRITE DATE FOR PLOT.
C
  264 WRITE(NOUT,612)MO,IDAY,IYR,G
C
C         WRITE NOON INTO TIME AXIS OF PLOT.
C
  612 FORMAT(1H ,5X,I2,2I3,3X,1HN,100A1,1HN)
      IF(Q(I,IH).GT.QMAX(I)) WRITE(NOUT,650)
  650 FORMAT(1H+,T123,2H++)
      IF(Q(I,IH).GT.0.0.AND.I.LE.5) WRITE(NOUT,652)Q(I,IH)
      IF(Q(I,IH).GT.0.0.AND.I.EQ.6) WRITE(NOUT,6522)Q(I,IH)
```

Table A-4 (Concluded)

```
  652 FORMAT(1H+,T125,F8.0)                                             PLOT110
 6522 FORMAT(1H+,T125,F8.3)                                             PLOT111
      GO TO 298                                                         PLOT112
  304 CONTINUE                                                          PLOT113
C                                                                       PLOT114
C          WRITE MIDNIGHT INTO TIME AXIS OF PLOT.                       PLOT115
C                                                                       PLOT116
  274 WRITE(NOUT,614)G                                                  PLOT117
  614 FORMAT(1H ,16X,1HM,100A1,1HM)                                     PLOT118
      IF(Q(I,IH).GT.0.0.AND.I.LE.5) WRITE(NOUT,652)Q(I,IH)              PLOT119
      IF(Q(I,IH).GT.0.0.AND.I.EQ.6) WRITE(NOUT,6522)Q(I,IH)             PLOT120
      IF(Q(I,IH).GT.QMAX(I)) WRITE(NOUT,650)                            PLOT121
      GO TO 298                                                         PLOT122
  306 CONTINUE                                                          PLOT123
  284 IF(IH.EQ.3.OR.IH.EQ.6.OR.IH.EQ.9) GO TO 412                       PLOT124
      IF(IH.EQ.15.OR.IH.EQ.18.OR.IH.EQ.21) GO TO 414                    PLOT125
      WRITE(NOUT,610)G                                                  PLOT126
  610 FORMAT(1H ,16X,1H-,100A1,1H-)                                     PLOT127
      GO TO 416                                                         PLOT128
C                                                                       PLOT129
C          WRITE HOUR VALUE INTO TIME AXIS OF PLOT.                     PLOT130
C                                                                       PLOT131
  412 WRITE(NOUT,654)IH,G,IH                                            PLOT132
  654 FORMAT(1H ,16X,I1,100A1,I1)                                       PLOT133
      GO TO 416                                                         PLOT134
  414 WRITE(NOUT,654)IQ,G,IQ                                            PLOT135
  416 IF(Q(I,IH).GT.0.0.AND.I.LE.5) WRITE(NOUT,652)Q(I,IH)              PLOT136
      IF(Q(I,IH).GT.0.0.AND.I.EQ.6) WRITE(NOUT,6522)Q(I,IH)             PLOT137
      IF(Q(I,IH).GT.QMAX(I)) WRITE(NOUT,650)                            PLOT138
  298 CONTINUE                                                          PLOT139
  202 CONTINUE                                                          PLOT140
      RETURN                                                            PLOT141
      END                                                               PLOT142
C=======================================================================DATA  1
      BLOCK DATA                                                        DATA  2
      COMMON/BLK1/A(13),ASTER,BLANK,X(6,4)                              DATA  3
      DATA A/' JAN',' FEB',' MAR',' APR',' MAY',' JUN',' JUL',' AUG',   DATA  4
     @ 'SEPT',' OCT',' NOV',' DEC','++++'/                              DATA  5
      REAL ASTER,BLANK,X                                                DATA  6
      DATA ASTER,BLANK/1H*,1H /                                         DATA  7
      DATA X/4HFLOW,4H BOD,4H  SS,4H BOD,4H  SS,4HOVFL,4HRATE,4HLOAD,   DATA  8
     @      4HLOAD,4HCONC,4HCONC,4HVOL.,3HMGA,3HLBS,3HLBS,3H MG,3H MG,  DATA  9
     @      3HMGA,4HL/D ,4H/HR ,4H/HR ,4H/L  ,4H/L  ,4HL/HR/            DATA 10
      END                                                               DATA 11
```

Table A-5. HISTO PROGRAM VARIABLES LIST

Variable name	Index*	Description	Unit
A	C,O	Abbreviation for name of month	--
ASTER	C	Plotting symbol (asterisk)	--
A1	I,C,O	1st numerical label for Y-axis (flowrate)	Mgal/d
A2	I,C,O	2nd numerical label for Y-axis (flowrate)	Mgal/d
A3	I,C,O	3rd numerical label for Y-axis (flowrate)	Mgal/d
A4	I,C,O	4th numerical label for Y-axis (flowrate)	Mgal/d
A5	I,C,O	5th numerical label for Y-axis (flowrate)	Mgal/d
A6	I,C,O	6th numerical label for Y-axis (flowrate)	Mgal/d
A7	I,C,O	7th numerical label for Y-axis (flowrate)	Mgal/d
A8	I,C,O	8th numerical label for Y-axis (flowrate)	Mgal/d
A9	I,C,O	9th numerical label for Y-axis (flowrate)	Mgal/d
A10	I,C,O	10th numerical label for Y-axis (flowrate)	Mgal/d
A11	I,C,O	11th numerical label for Y-axis (flowrate)	Mgal/d
BLANK	C	Plotting symbol (blank)	--
B1	I,C,O	1st numerical label for Y-axis (BOD load)	lb/h
B2	I,C,O	2nd numerical label for Y-axis (BOD load)	lb/h
B3	I,C,O	3rd numerical label for Y-axis (BOD load)	lb/h
B4	I,C,O	4th numerical label for Y-axis (BOD load)	lb/h
B5	I,C,O	5th numerical label for Y-axis (BOD load)	lb/h
B6	I,C,O	6th numerical label for Y-axis (BOD load)	lb/h
B7	I,C,O	7th numerical label for Y-axis (BOD load)	lb/h
B8	I,C,O	8th numerical label for Y-axis (BOD load)	lb/h
B9	I,C,O	9th numerical label for Y-axis (BOD load)	lb/h
B10	I,C,O	10th numerical label for Y-axis (BOD load)	lb/h
B11	I,C,O	11th numerical label for Y-axis (BOD load)	lb/h
C1	I,C,O	1st numerical label for Y-axis (SS load)	lb/h
C2	I,C,O	2nd numerical label for Y-axis (SS load)	lb/h
C3	I,C,O	3rd numerical label for Y-axis (SS load)	lb/h
C4	I,C,O	4th numerical label for Y-axis (SS load)	lb/h
C5	I,C,O	5th numerical label for Y-axis (SS load)	lb/h
C6	I,C,O	6th numerical label for Y-axis (SS load)	lb/h
C7	I,C,O	7th numerical label for Y-axis (SS load)	lb/h
C8	I,C,O	8th numerical label for Y-axis (SS load)	lb/h
C9	I,C,O	9th numerical label for Y-axis (SS load)	lb/h
C10	I,C,O	10th numerical label for Y-axis (SS load)	lb/h
C11	I,C,O	11th numerical label for Y-axis (SS load)	lb/h
DATE	I,C,O	Calendar date for computer run	--
DSTART	I,C,O	Day of month for start of desired printout	--
DSTOP	I,C,O	Day of month end of desired printout	--
D1	I,C,O	1st numerical label for Y-axis (BOD concentration)	mg/L
D2	I,C,O	2nd numerical label for Y-axis (BOD concentration)	mg/L
D3	I,C,O	3rd numerical label for Y-axis (BOD concentration)	mg/L
D4	I,C,O	4th numerical label for Y-axis (BOD concentration)	mg/L
D5	I,C,O	5th numerical label for Y-axis (BOD concentration)	mg/L
D6	I,C,O	6th numerical label for Y-axis (BOD concentration)	mg/L
D7	I,C,O	7th numerical label for Y-axis (BOD concentration)	mg/L
D8	I,C,O	8th numerical label for Y-axis (BOD concentration)	mg/L
D9	I,C,O	9th numerical label for Y-axis (BOD concentration)	mg/L
D10	I,C,O	10th numerical label for Y-axis (BOD concentration)	mg/L
D11	I,C,O	11th numerical label for Y-axis (BOD concentration)	mg/L

Table A-5 (Continued)

Variable name	Index*	Description	Unit
E1	I,C,O	1st numerical label for Y-axis (SS concentration)	mg/L
E2	I,C,O	2nd numerical label for Y-axis (SS concentration)	mg/L
E3	I,C,O	3rd numerical label for Y-axis (SS concentration)	mg/L
E4	I,C,O	4th numerical label for Y-axis (SS concentration)	mg/L
E5	I,C,O	5th numerical label for Y-axis (SS concentration)	mg/L
E6	I,C,O	6th numerical label for Y-axis (SS concentration)	mg/L
E7	I,C,O	7th numerical label for Y-axis (SS concentration)	mg/L
E8	I,C,O	8th numerical label for Y-axis (SS concentration)	mg/L
E9	I,C,O	9th numerical label for Y-axis (SS concentration)	mg/L
E10	I,C,O	10th numerical label for Y-axis (SS concentration)	mg/L
E11	I,C,O	11th numerical label for Y-axis (SS concentration)	mg/L
F	I,C,O	Range values for summary tables	Varies
G	C,O	Array of symbols to be plotted	--
I	O	Do loop counter	--
IDAY	I,C,O	Day of month from tape or disk input file	--
IH	O	Do loop counter	--
II		Do loop counter	--
IPLOT	I,C,O	Flag for plotting histograms	--
IPLT	I,C,O	Flag for plotting individual histograms	--
IQ	O	Hour for X-axis label	--
ISTART	I,C,O	Year for start of desired printout	--
ISTOP	I,C,O	Year for end of desired printout	--
ITAB	I,C,O	Flag for printing individual summary table	--
ITABLE	I,C,O	Flag for printing summary tables	--
IYR	I,C,O	Year for tape or disk input file	--
J	--	Do loop counter	--
JJ	--	Do loop counter	--
JOUT	I,C,O	Arrary of output disk/tape units	--
K		Do loop counter	--
KDAYS	C,O	Day counter	--
KFLAG	C	Flag for disk/tape input file printout start	--
KOUNT	C,O	Hour counter	--
KT	C,O	Hour counter	--
KTOT	C	Hour counter	--
KUMTOT	C,O	Hour counter	--
L	C	Do loop counter	--
M		Do loop counter	--
MJ		Do loop counter	--
MO	I,C,O	Month from disk/tape input file	--
MOSTAR	I,C,O	Month for start of desired printout	--
MOSTOP	I,C,O	Month for end of desired printout	--
NOUT	C	Number of output disk/tape unit for plot	--
N5	C	Card input unit number	--
N6	C	Printer output unit number	--
N8	C	Disk/tape input unit number	--
PEAK	C,O	Maximum hourly value	Varies
PLOT		Subroutine name	--
Q	C,O	Hourly value for plots or tables	Varies
QK	C	Array for value for plotting symbol	Varies
QLOW	C,O	QMax/100	Varies
QMAX	I,C,O	Maximum value for plots	Varies
RANGES		Subrouting name	--

Table A-5 (Concluded)

Variable name	Index	Description	Unit
TABLES		Subroutine name	--
TITLE1	I,C,O	80 character descriptive title	--
TITLE2	I,C,O	80 character descriptive title	--
TITLE3	I,C,O	80 character descriptive title	--
TRB	I,C	Hourly BOD load	klb/h
TRF	I,C	Hourly flowrate	Mgal/h
TRS	I,C	Hourly SS load	klb/h
X	C,O	Array for horizontal axis labels	Varies
Z1	I,C,O	1st numerical label for X-axis (flow volume)	Mgal/h
Z2	I,C,O	2nd numerical label for X-axis (flow volume)	Mgal/h
Z3	I,C,O	3rd numerical label for X-axis (flow volume)	Mgal/h
Z4	I,C,O	4th numerical label for X-axis (flow volume)	Mgal/h
Z5	I,C,O	5th numerical label for X-axis (flow volume)	Mgal/h
Z6	I,C,O	6th numerical label for X-axis (flow volume)	Mgal/h
Z7	I,C,O	7th numerical label for X-axis (flow volume)	Mgal/h
Z8	I,C,O	8th numerical label for X-axis (flow volume)	Mgal/h
Z9	I,C,O	9th numerical label for X-axis (flow volume)	Mgal/h
Z10	I,C,O	10th numerical label for X-axis (flow volume)	Mgal/h
Z11	I,C,O	11th numerical label for X-axis (flow volume)	Mgal/h

NOTE: I = Input variable
C = Common variable
O = Output variable

Table A-6. VDAY PROGRAM LISTING

```
C      *********************************************
C        MAC MODEL      VERSION=EPAMAC1      08/15/80
C
C                       VDAY PROGRAM
C
C                     EPA  APPLICATION
C
C      *********************************************
C      DEVELOPER: WILLIAM G. SMITH
C                 METCALF & EDDY, INC., ENGINEERS
C                 P.O. BOX 10-046
C                 1029 CORPORATION WAY
C                 PALO ALTO, CALIF. 94303
C                    TEL:  415/964-7100
C      *********************************************
C
C      THIS COMPUTER PROGRAM WAS DEVELOPED BY METCALF & EDDY, INC.,
C      AND REFINED IN CONNECTION WITH THE SAN FRANCISCO SOUTHWEST
C      WPCP PROJECT, DPW ORDER NO.  108,332.  THIS MODEL WAS THEN
C      GENERALIZED AND DOCUMENTED FOR THE U.S. ENVIRONMENTAL
C      PROTECTION AGENCY IN CONNECTION WITH THE DEVELOPMENT OF
C      PLANNING AND DESIGN PRINCIPLES FOR URBAN STORM WATER
C      AND COMBINED SEWER OVERFLOWS TREATMENT CONTROL FACILITIES,
C      CONTRACT NO. 68-03-2877.
C                 ----  JUNE  24, 1981  ----
C
C      *********************************************
C
C=======================================================================
C     MAIN PROGRAM
      COMMON/BLK1/  XSQ(43),COLI(24),NVDA(70,12,31),EFLOW(7000),
     @              OFLOW(24),RFLOW(24),TITLE(40)
      INTEGER Y,EVENT1,EVENT2
      INTEGER*2 IRC10M(70,12,31),IRC240(70,12,31),ISHL70(70,12,31),
     @          ISH10M(70,12,31),ISH230(70,12,31),NVDA
      REAL NEWVOL
      COMMON/BLK2/  NDX(70,12),NEV(70,12),NRH(70,12),NRX(70,12),
     @              NVD(70,12),MONTH(70,12),NDAYS(70,12),NCALYR(70,12)
      INTEGER*2 NDX,NEV,NRH,NRX,NVD,MONTH,NDAYS,NCALYR
      COMMON/BLK3/  PCTCRX(70,12),PCTCVD(70,12)
      COMMON/BLK4/  KPAGE
      COMMON/BLK5/  X,N5,N6
      COMMON/BLK6/  NWEV(70,12),NWRH(70,12),NWATYR(70,12),NWDAYS(70,12)
      INTEGER*2 NWEV,NWRH,NWATYR,NWDAYS
      COMMON/BLK7/  NWDX(70,12),NWRX(70,12),NWVD(70,12)
      INTEGER*2 NWDX,NWRX,NWVD
      COMMON/BLK8/  MONW(70,12)
      INTEGER*2 MONW
      COMMON/BLK9/  PCTRX(70,12),PCTVD(70,12)
      COMMON/BLK11/ NRYR(70),NWYR(70),NEVYR(70),NRXYR(70),NANNVD(70),
     @              NWDXYR(70)
      INTEGER*2 NRYR,NWYR,NEVYR,NRXYR,NANNVD,NWDXYR
      COMMON/BLK12/ L95(43),L90(43),L85(43),L80(43),L75(43),
     @              L70(43),L65(43),L60(43),L55(43),L50(43),L45(43),
     @              L40(43),L35(43),L30(43),L25(43),L20(43),L15(43),
     @              L10(43),L5(43)
      INTEGER*2 L95,L90,L85,L80,L75,L70,L65,L60,L55,L50,L45,L40,L35,
     @          L30,L25,L20,L15,L10,L5
      COMMON/BLK13/ Q95(43),Q90(43),Q85(43),Q80(43),Q75(43),
     @              Q70(43),Q65(43),Q60(43),Q55(43),Q50(43),Q45(43),
```

Table A-6 (Continued)

```
     @                Q40(43),Q35(43),Q30(43),Q25(43),Q20(43),Q15(43),
     @                Q10(43),Q5(43)
      COMMON/BLK14/ XTOT(43),XAVG(43),XSIG(43),VMAX(43),VMIN(43),
     @                P95(43),P90(43),P85(43),P80(43),P75(43),P70(43),
     @                P65(43),P60(43),P55(43),P50(43),P45(43),P40(43),
     @                P35(43),P30(43),P25(43),P20(43),P15(43),P10(43),
     @                P5(43),NYL1
      COMMON/BLK15/ MON(12),CREC(5),CSHEL(30),CSTAT(19)
      COMMON/BLK21/ DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP
      INTEGER   DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP
      COMMON/BLK22/ NYEARS,NM1,NM2
 1999 CONTINUE
      KFLAG=0
      N5=5
      N6=6
C            ----------
C            READ INPUT DATA FROM CARDS
C            ----------
C     -----
C     TWO CARDS FOR TITLE
C     -----
      READ(N5,7020) TITLE
 7020 FORMAT(20A4)
      READ(N5,7022) DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP
 7022 FORMAT(6I5)
      IF(MOSTAR.EQ.0.OR.ISTART.EQ.0.OR.MOSTOP.EQ.0.OR.ISTOP.EQ.0)KFLAG=1
      IF(MOSTAR.EQ.0) MOSTAR=13
      IF(MOSTOP.EQ.0) MOSTOP=13
C     -----
C     X = MINIMUM OVERFLOW VOLUME, MGAL/DAY
C     Y = NO. OF HOURS W/O OVERFLOW BETWEEN OVERFLOW EVENTS
C     NIN = NO. OF INPUT FILE FROM TAPE OR DISK
C     NYL = LAST TWO DIGITS OF LAST YEAR WITH RAIN
C     KSUM  =0  SKIP SUMMARY TABLE
C           =1  PRINT   "      "
C     KWAT  =0  SKIP WATER YEAR SUMMARY TABLE (CHRONOLOGICAL ORDER)
C           =1  PRINT  "    "      "      "          "           "
C     KSEQ  =0  SKIP SEQUENCED WATER YEAR SUMMARY TABLE
C           =1  PRINT    "       "    "      "      "
C     KWGS  = 9999FOR LAST INPUT DATA CARD WHEN MULTIPLE RUNS.
C             OTHERWISE, LEAVE BLANK.
C     -----
      READ(N5,501) X,Y,NIN,NYL,KSUM,KWAT,KSEQ,KWGS
  501 FORMAT(F5.2,9I5)
      NYL1=NYL
      NYL1M1=NYL1-1
      REWIND NIN
C     -----
C      BNEWR = ATTENUATION COEFFICIENT READ AS INPUT VARIABLE
C      IF BNEWR = 0.0, ATTENUATION COEFFICIENT IS A VARIABLE
C      IF BNEWR > 0.0, ATTENUATION COEFFICIENT IS A CONSTANT
C     -----
      READ(N5,7040) BNEWR,CB,BMULT,ALPHA,BETA
 7040 FORMAT(F10.0,E10.0,3F10.0)
      WRITE(N6,7060) TITLE
 7060 FORMAT(1H1,///,10X,20A4,/,10X,20A4)
      WRITE(N6,7081) MOSTAR,DSTART,ISTART
 7081 FORMAT(1H ,/,' BEGINNING DATE:',I3,'-',I2,'-19',I2)
      IF(ISTART.LT.10) WRITE(N6,7082)
 7082 FORMAT(1H+,24X,'0')
```

Table A-6 (Continued

```
      WRITE(N6,7083) MOSTOP,DSTOP,ISTOP
 7083 FORMAT(1H ,/,' ENDING DATE:   ',I3,'-',I2,'-19',I2)
      IF(ISTOP.LT.10) WRITE(N6,7082)
      WRITE(N6,7084) X,Y,NIN,NYL,KSUM,KWAT,KSEQ,KWGS
 7084 FORMAT(1H ,///,' X (MINIMUN OVERFLOW VOLUME, MGAL/DAY) =',F7.2,
     @ /,' Y (NO. OF HOURS W/O OVERFLOW BETWEEN OVERFLOW EVENTS) =',I3,
     @ /,' NIN (NO. OF INPUT FILE FROM TAPE OR DISK) =',I4,
     @ /,' NYL (LAST TWO DIGITS OF YEAR PRIOR TO STARTING YEAR) =',I4,
     @ /,' KSUM (0 = SKIP, 1 = PRINT SUMMARY TABLE) =',I4,
     @ /,' KWAT (0 = SKIP, 1 = PRINT WATER YEAR SUMMARY TABLE (CHRONOLOG
     @ICAL ORDER)) =',I4,
     @ /,' KSEQ (0 = SKIP, 1 = PRINT SEQUENCED WATER YEAR SUMMARY TABLE)
     @ =',I4,
     @ /,' KWGS (LAST DATA CARD SET IDENTIFIER) =',I6,///)
      WRITE(N6,7080) BNEWR,CB,BMULT,ALPHA,BETA
 7080 FORMAT(/,
     @         ' ATTENUATION COEFFICIENT (BNEWR) =',F8.4,/,
     @         ' OVERFLOW COLIFORM (CB) IS ',1P,E10.4,
     @         ' MPN/100 ML',/,' INITIAL ',
     @      ' COLIFORM CONCENTRATION MULTIPLIER (BMULT) IS ',1P,E10.1,/,
     @  ' COLIFORM CONCENTRATION CORRECTION FACTOR (ALPHA) IS',0P,F10.6,
     @     /,' COLIFORM CONCENTRATION EXPONENTIATION FACTOR (BETA) IS',
     @        F10.6,///)
C             ----------
C             BEGIN VARIABLE INITIALIZATION
C             ----------
      DO 1 I=1,70
        DO 1 J=1,12
          NCALYR(I,J)=I+NYL1+1900-1
          MONTH(I,J)=J
          IF(MONTH(I,J)-2) 5,2,5
C         ----------
C         CHECK FOR LEAP YEAR
C         ----------
    2     XL=NCALYR(I,J)
          XL=XL/4.
          L=XL
          XXL=L
          IF(XL-XXL)5,4,5
C            ----------
C            FOR LEAP YEAR, SET NUMBER OF DAYS IN
C            FEBRUARY TO 29
C            ----------
    4     NDAYS(I,J)=29
          GO TO 6
    5     CONTINUE
          NDAYS(I,J)=MON(J)
    6     NRH(I,J)=0
          NRX(I,J)=0
          NDX(I,J)=0
          NEV(I,J)=0
          NVD(I,J)=0
    1   CONTINUE
      DO 3 J=1,7000
    3   EFLOW(J)=0.0
      JXX=0
      JX=0
      JCC=0
      NRHM=0
      NRXM=0
```

Table A-6 (Continued)

```
      NDXM=0                                                            MAIN181
      LASTMO=1                                                          MAIN182
      CS=60.                                                            MAIN183
      CTOT=60.                                                          MAIN184
      CBAR=60.                                                          MAIN185
      CW=60.                                                            MAIN186
      T=0.                                                              MAIN187
      OVOL=0.                                                           MAIN188
      CO=1.0                                                            MAIN189
      EVENT1=0                                                          MAIN190
      EVENT2=1                                                          MAIN191
      BNEW=0.                                                           MAIN192
      DO 801 I=1,70                                                     MAIN193
        DO 801 J=1,12                                                   MAIN194
          DO 801 K=1,31                                                 MAIN195
            NVDA(I,J,K)=0                                               MAIN196
            IRC10M(I,J,K)=0                                             MAIN197
            IRC240(I,J,K)=0                                             MAIN198
            ISHL70(I,J,K)=0                                             MAIN199
            ISH230(I,J,K)=0                                             MAIN200
            ISH10M(I,J,K)=0                                             MAIN201
  801   CONTINUE                                                        MAIN202
C            ----------                                                 MAIN203
C            END VARIABLE INITIALIZATION                                MAIN204
C            ----------                                                 MAIN205
  111 CONTINUE                                                          MAIN206
      READ(NIN) NY,MO,ND,RFLOW                                          MAIN207
      IF(KFLAG.EQ.0) GO TO 112                                          MAIN208
      DSTART=ND                                                         MAIN209
      MOSTAR=MO                                                         MAIN210
      ISTART=NY                                                         MAIN211
      DSTOP=ND                                                          MAIN212
  112 CONTINUE                                                          MAIN213
      IF(NY.LT.ISTART) GO TO 111                                        MAIN214
      IF(MO.LT.MOSTAR.AND.NY.EQ.ISTART) GO TO  111                      MAIN215
      IF(ND.LT.DSTART.AND.MO.EQ.MOSTAR.AND.NY.EQ.ISTART) GO TO 111      MAIN216
      DO 298 I=1,24                                                     MAIN217
        IF(RFLOW(I)) 22,22,32                                           MAIN218
   32   IF(JXX.EQ.0) JX=JX+1                                            MAIN219
C                                                                       MAIN220
C                                                                       MAIN221
        IF (JXX.EQ.0.0) EVENT1=EVENT1+1                                 MAIN222
        EFLOW(EVENT1) = EFLOW(EVENT1) + RFLOW(I)                        MAIN223
        JXX=1                                                           MAIN224
        JCC=0                                                           MAIN225
        GO TO 298                                                       MAIN226
   22   JCC=JCC+1                                                       MAIN227
        IF(JCC.LE.Y) GO TO 298                                          MAIN228
        JXX=0                                                           MAIN229
  298   CONTINUE                                                        MAIN230
   10 CONTINUE                                                          MAIN231
      DO 50 J=1,24                                                      MAIN232
   50   OFLOW(J)=RFLOW(J)                                               MAIN233
C     NY = YEAR                                                         MAIN234
C     MO = MONTH                                                        MAIN235
C     ND = DAY                                                          MAIN236
C     FLOW = HOURLY RAINFALL, IN/HR                                     MAIN237
      READ(NIN,END=2001) NY,MO,ND,RFLOW                                 MAIN238
      IF(KFLAG.EQ.0) GO TO 113                                          MAIN239
      DSTOP=ND                                                          MAIN240
```

Table A-6 (Continued)

```
      MOSTOP=MO
      ISTOP=NY
      GO TO 114
  113 IF(NY.GT.ISTOP) GO TO 2001
      IF(NY.EQ.ISTOP.AND.MO.GT.MOSTOP) GO TO 2001
      IF(NY.EQ.ISTOP.AND.MO.EQ.MOSTOP.AND.ND.GT.DSTOP) GO TO 2001
      KDAYS=KDAYS+1
  114 CONTINUE
      IF(NY-99) 100,2000,2000
  100 CONTINUE
      IF(MO-LASTMO) 2000,110,2000
  110 CONTINUE
 3000 IF(JXX) 300,240,240
  300 WRITE(N6,600) JXX,NY,MO,ND
  600 FORMAT(1H1,10X,36HSTORM IN PROGRESS INDEX IS NEGATIVE,,
     @       I4,10X,3(1X,I2))
      STOP 300
  240 IF (NY.EQ.99) GOTO 700
      DO 299 I=1,24
        IF(RFLOW(I)) 20,20,30
   30   IF(JXX.EQ.0) JX=JX+1
C       .
C       IF IN A NEW EVENT, INCREMENT EVENT1 COUNTER
C
        IF (JXX.EQ.0.0) EVENT1=EVENT1+1
        EFLOW(EVENT1) = EFLOW(EVENT1) + RFLOW(I)
        JXX=1
        JCC=0
        GO TO 299
   20   JCC=JCC+1
        IF(JCC.LE.Y) GO TO 299
        JXX=0
  299   CONTINUE
  700 DO 710 I=1,24
        IF(OFLOW(I)) 710,710,720
  720   NRHM=NRHM+1
  710   CONTINUE
      NYL=NY
      LASTMO=MO
      DO 799 I=1,24
        IF(OFLOW(I)-X) 799,799,716
  716   NRXM=NRXM+1
  799   CONTINUE
C
C     CALCULATE COLIFORM CONCENTRATION FOR EACH HOUR
C
      DO 1700 I=1,24
        OVOL = OVOL + OFLOW(I)
        IF (OVOL.LE.0.0) GOTO 1710
        IF (OVOL.NE.EFLOW(EVENT2)) GOTO 1710
C            ----------
C            ALL OF EVENT SPILL IS NOW SUMMATED IN OVOL
C            ----------
        T = 0.
C            ----------
C            ZERO OUT EVENT CLOCK
C            ----------
        EVENT2 = EVENT2 + 1
        NEWVOL = OVOL   36.8292
C            ----------
```

Table A-6 (Continued)

```
C            NEWVOL IS VOLUME OF SPILL IN ACRE-INCH                     MAIN301
C            36.8292*MGAL = ACRE-INCH                                   MAIN302
C            ----------                                                 MAIN303
        OVOL = 0.                                                       MAIN304
C            ----------                                                 MAIN305
C            RE-INITIALIZE TEST FOR SIZE OF EVENT SPILL                 MAIN306
C            ----------                                                 MAIN307
        CO = NEWVOL*CB                                                  MAIN308
C            ----------                                                 MAIN309
C            CO = NUMBER OF COLIFORM IN SPILL                           MAIN310
C                    = CONCENTRATION OF COLIFORM IN SPILL (INPUT DATUM) MAIN311
C                      * VOLUME OF SPILL, IN ACRE-INCH                  MAIN312
C            ----------                                                 MAIN313
        CR = BMULT * ALPHA * (CO**BETA)                                 MAIN314
C            ----------                                                 MAIN315
C            NOTE : CR = COLIFORM CONCENTRATION IN REVEIVING WATERS     MAIN316
C                         EQUATION IS AN EMPIRICAL RELATIONSHIP BASED ONMAIN317
C                         ACRE-INCH OF OVERFLOW VOLUME                  MAIN318
C                        DERIVED FROM BEST CURVE FIT OF                 MAIN319
C                         J. B. GILBERT 1978 SAMPLING DATA              MAIN320
C            ----------                                                 MAIN321
        OLDVOL=((CTOT/ALPHA)**(1./BETA))/CB                             MAIN322
        CR = CR + CTOT                                                  MAIN323
C            ----------                                                 MAIN324
C            CONCENTRATION = SPILL CONCENTRATION PLUS EXISTING          MAIN325
C            (PREVIOUS SPILL OR BACKGROUND) CONCENTRATION               MAIN326
C            ----------                                                 MAIN327
        IF (CR.GT.CO) CR = CO                                           MAIN328
C            ----------                                                 MAIN329
C                  CHECK TO SEE WHICH COMPUTATION METHOD IS TO BE USED  MAIN330
C                    BNEWR = 0.0, USE NEW J.B.GILBERT METHOD            MAIN331
C                    BNEWR > 0.0, USE ATTENUATION COEFFICIENT = CONSTANTMAIN332
C            ----------                                                 MAIN333
        IF(BNEWR.GT.0.0) BNEW=BNEWR                                     MAIN334
        IF(BNEWR.GT.0.0) GO TO 1710                                     MAIN335
C            ----------                                                 MAIN336
C            CHECK TO MAKE SURE RECEIVING WATER CONCENTRATION IS NOT    MAIN337
C            GREATER THAN SPILL CONCENTRAION ('DOES NOT COMPUTE')       MAIN338
C            ----------                                                 MAIN339
        BNEW=0.0                                                        MAIN340
        IF (NEWVOL.GT.0.0) BNEW = 0.0128 + 0.00421*ALOG(NEWVOL+OLDVOL)  MAIN341
C            ----------                                                 MAIN342
C            NOTE : BNEW IS AN EXPONENTIAL DECAY FACTOR                 MAIN343
C                    VIA AN EMPIRICAL EQUATION BASED ON OVERFLOW VOLUME MAIN344
C                    THE BIGGER THE VOLUME, THE SLOWER THE DECAY        MAIN345
C            ----------                                                 MAIN346
        IF (BNEW.LT.0.) BNEW = 0.0                                      MAIN347
 1710   T = T+1                                                         MAIN348
C            ----------                                                 MAIN349
C            EVENT CLOCK IS RUNNING                                     MAIN350
C            ----------                                                 MAIN351
        CPARLN = (-BNEW) * T                                            MAIN352
C            ----------                                                 MAIN353
C            DECAY EXPONENT, INCREASING WITH TIME                       MAIN354
C            ----------                                                 MAIN355
        CPAR = 0.                                                       MAIN356
        IF (CPARLN.GT.(-170.)) CPAR = EXP(CPARLN)                       MAIN357
C            ----------                                                 MAIN358
C            DECAY FACTOR AS EXPONENTIAL FRACTION                       MAIN359
C            ----------                                                 MAIN360
```

Table A-6 (Continued)

```
        CTOT =  CR * CPAR
C           ----------
C           CTOT = COLIFORM CONCENTRATION TRACKED
C                    = EXPONENTIALLY DECREASING FRACTION OF
C                      CONCENTRATION PRESENT AT START OF SPILL
C           ----------
        IF (CTOT.LT.CS) CTOT = CS
C           ----------
C           COLIFORM CONCENTRATION OF SPILL CANNOT BE
C           LESS THAN BACKGROUND
C           ----------
        COLI(I) = CTOT
 1700   CONTINUE
C
C     ADVANCE 5 DAYS OF RECORD ONE DAY
C
      DO 1500 J=2,5
 1500   CREC(J-1)=CREC(J)
      CREC(5)=COLI(12)
C
C     ADVANCE 30 DAYS OF RECORD ONE DAY
C
      DO 1510 J=2,30
 1510   CSHEL(J-1)=CSHEL(J)
      CSHEL(30)=COLI(12)
C
C     CHECK RECREATION COLIFORM LIMIT VIOLATIONS
C
      IF (COLI(12).LE.10000.) GOTO 1520
      IRC10M(NY-NYL1M1,MO,ND)=1
 1520 CONTINUE
      NMED=0
      DO 1530 J=1,5
        IF (CREC(J).GT.240.) NMED=NMED+1
 1530   CONTINUE
      IF (NMED.LE.2) GOTO 1540
      IRC240(NY-NYL1M1,MO,ND)=1
 1540 CONTINUE
C
C     CHECK SHELLFISH COLIFORM LIMIT VIOLATIONS
C
      NTEN=0
      NMED=0
      NTWENT=0
      DO 1550 J=1,30
        IF (CSHEL(J).GT.70.) NMED=NMED+1
        IF (CSHEL(J).GT.230.) NTEN=NTEN+1
        IF (CSHEL(J).GT.1000) NTWENT=NTWENT+1
 1550   CONTINUE
      IF (NMED.LE.15) GOTO 1560
      ISHL70(NY-NYL1M1,MO,ND)=1
 1560 CONTINUE
      IF (NTEN.LE.3) GOTO 1570
      ISH230(NY-NYL1M1,MO,ND)=1
 1570  CONTINUE
      IF (NTWENT.LE.6) GOTO 1580
      ISH10M(NY-NYL1M1,MO,ND)=1
C     IF IN A NEW EVENT, INCREMENT EVENT1 COUNTER
 1580 CONTINUE
      IF(NRXM.LE.NRXL) GO TO 750
```

Table A-6 (Continued)

```
      NVDA(NY-NYL1M1,MO,ND)=1                                           MAIN421
  361 CONTINUE                                                          MAIN422
      NDXM=NDXM+1                                                       MAIN423
      NRXL=NRXM                                                         MAIN424
  750 GO TO 10                                                          MAIN425
 2001 NY=99                                                             MAIN426
 2000 CONTINUE                                                          MAIN427
      NXZ=NYL-NYL1+1                                                    MAIN428
      NRH(NXZ,LASTMO)=NRHM                                              MAIN429
      NRX(NXZ,LASTMO)=NRXM                                              MAIN430
      NDX(NXZ,LASTMO)=NDXM                                              MAIN431
      NEV(NXZ,LASTMO)=JX                                                MAIN432
  803 NRHM=0                                                            MAIN433
      NRXM=0                                                            MAIN434
      NDXM=0                                                            MAIN435
      JX=0                                                              MAIN436
      NRXL=0                                                            MAIN437
      IF(NY.NE.99) GO TO 3000                                           MAIN438
      TIMEY=FLOAT(ISTOP-ISTART)                                         MAIN439
      TIMEM=FLOAT(MOSTOP-MOSTAR)                                        MAIN440
      TIMEX=TIMEY+((TIMEM+1.)/12.)                                      MAIN441
      NTIME=IFIX(TIMEX)                                                 MAIN442
      TIMER=TIMEX-FLOAT(NTIME)                                          MAIN443
      IF(TIMER.GE.0.5) TIMEX=TIMEX+1.                                   MAIN444
      NYEARS=IFIX(TIMEX)                                                MAIN445
       NM1=NYEARS-1                                                     MAIN446
       NM2=NYEARS-2                                                     MAIN447
      WRITE(N6,610) NYEARS,NM1,NM2,TIMEY,TIMEM,TIMEX,NTIME,TIMER        MAIN448
  610 FORMAT(////,' NYEARS =',I3,5X,'NM1 =',I3,5X,'NM2 =',I3,/,         MAIN449
     @       ' TIMEY =',F5.1,5X,'TIMEM =',F5.1,5X,'TIMEX =',F6.2,5X,    MAIN450
     @       ' NTIME =',I6,5X,'TIMER =',F6.2)                           MAIN451
      DO 1002 KQQ=1,5                                                   MAIN452
        GO TO (1600,1620,1640,1660,1680),KQQ                            MAIN453
 1600   DO 1601 I=1,NYEARS                                              MAIN454
          DO 1601 J=1,12                                                MAIN455
            NVD(I,J)=0                                                  MAIN456
            DO 1601 K=1,31                                              MAIN457
              NVDA(I,J,K)=0                                             MAIN458
 1601     CONTINUE                                                      MAIN459
        DO 1602 I=1,NYEARS                                              MAIN460
          DO 1602 J=1,12                                                MAIN461
            DO 1602 K=1,31                                              MAIN462
              NVDA(I,J,K)=IRC10M(I,J,K)                                 MAIN463
 1602     CONTINUE                                                      MAIN464
        GOTO 1690                                                       MAIN465
 1620   DO 1621 I=1,NYEARS                                              MAIN466
          DO 1621 J=1,12                                                MAIN467
            NVD(I,J)=0                                                  MAIN468
            DO 1621 K=1,31                                              MAIN469
              NVDA(I,J,K)=0                                             MAIN470
 1621     CONTINUE                                                      MAIN471
        DO 1622 I=1,NYEARS                                              MAIN472
          DO 1622 J=1,12                                                MAIN473
            DO 1622 K=1,31                                              MAIN474
              NVDA(I,J,K)=IRC240(I,J,K)                                 MAIN475
 1622     CONTINUE                                                      MAIN476
        GOTO 1690                                                       MAIN477
 1640   DO 1641 I=1,NYEARS                                              MAIN478
          DO 1641 J=1,12                                                MAIN479
            NVD(I,J)=0                                                  MAIN480
```

Table A-6 (Continued)

```
          DO 1641 K=1,31                                                MAIN481
            NVDA(I,J,K)=0                                               MAIN482
 1641   CONTINUE                                                        MAIN483
      DO 1642 I=1,NYEARS                                                MAIN484
        DO 1642 J=1,12                                                  MAIN485
          DO 1642 K=1,31                                                MAIN486
            NVDA(I,J,K)=ISHL70(I,J,K)                                   MAIN487
 1642   CONTINUE                                                        MAIN488
      GOTO 1690                                                         MAIN489
 1660 DO 1661 I=1,NYEARS                                                MAIN490
        DO 1661 J=1,12                                                  MAIN491
          NVD(I,J)=0                                                    MAIN492
          DO 1661 K=1,31                                                MAIN493
            NVDA(I,J,K)=0                                               MAIN494
 1661   CONTINUE                                                        MAIN495
      DO 1662 I=1,NYEARS                                                MAIN496
        DO 1662 J=1,12                                                  MAIN497
          DO 1662 K=1,31                                                MAIN498
            NVDA(I,J,K)=ISH230(I,J,K)                                   MAIN499
 1662   CONTINUE                                                        MAIN500
      GOTO 1690                                                         MAIN501
 1680 DO 1681 I=1,NYEARS                                                MAIN502
        DO 1681 J=1,12                                                  MAIN503
          NVD(I,J)=0                                                    MAIN504
          DO 1681 K=1,31                                                MAIN505
            NVDA(I,J,K)=0                                               MAIN506
 1681   CONTINUE                                                        MAIN507
      DO 1682 I=1,NYEARS                                                MAIN508
        DO 1682 J=1,12                                                  MAIN509
          DO 1682 K=1,31                                                MAIN510
            NVDA(I,J,K)=ISH10M(I,J,K)                                   MAIN511
 1682   CONTINUE                                                        MAIN512
 1690 CONTINUE                                                          MAIN513
      DO 49 I=1,NYEARS                                                  MAIN514
        DO 49 J=1,12                                                    MAIN515
          DO 49 K=1,31                                                  MAIN516
            NVD(I,J)=NVD(I,J)+NVDA(I,J,K)                               MAIN517
   49   CONTINUE                                                        MAIN518
      KPAGE=0                                                           MAIN519
C     ----------                                                        MAIN520
C     % BY CALENDER YEAR                                                MAIN521
C     ----------                                                        MAIN522
      DO 903 I=1,NYEARS                                                 MAIN523
        DO 903 J=1,12                                                   MAIN524
          A=NDAYS(I,J)*24.                                              MAIN525
          B=NRX(I,J)                                                    MAIN526
          C=NVD(I,J)*24.                                                MAIN527
          PCTCRX(I,J)=B*100./A                                          MAIN528
          PCTCVD(I,J)=C*100./A                                          MAIN529
  903   CONTINUE                                                        MAIN530
      IF(KSUM.EQ.1.AND.KQQ.EQ.1) CALL SUMM(KQQ)                         MAIN531
 1995 CONTINUE                                                          MAIN532
      DO 912 I=1,NYEARS                                                 MAIN533
        DO 912 J=1,12                                                   MAIN534
          NWATYR(I,J)=0                                                 MAIN535
          MONW(I,J)=0                                                   MAIN536
          NWDAYS(I,J)=0                                                 MAIN537
          NWRH(I,J)=0                                                   MAIN538
          NWRX(I,J)=0                                                   MAIN539
          NWDX(I,J)=0                                                   MAIN540
```

Table A-6 (Continued)

```
            NWEV(I,J)=0
            NWVD(I,J)=0
  912     CONTINUE
C       ----------
C       REORDER BY WATER YEAR  (JULY 1 - JUNE 30)
C       ----------
        DO 901 I=1,NYEARS
          DO 901 J=1,6
            NWATYR(I,J)=NCALYR(I,J+6)
            MONW(I,J)=MONTH(I,J+6)-6
            NWDAYS(I,J)=NDAYS(I,J+6)
            NWRH(I,J)=NRH(I,J+6)
            NWRX(I,J)=NRX(I,J+6)
            NWDX(I,J)=NDX(I,J+6)
            NWEV(I,J)=NEV(I,J+6)
            NWVD(I,J)=NVD(I,J+6)
            PCTRX(I,J)=PCTCRX(I,J+6)
            PCTVD(I,J)=PCTCVD(I,J+6)
  901     CONTINUE
        DO 902 I=1,NM1
          DO 902 J=7,12
            NWATYR(I,J)=NCALYR(I+1,J-6)-1
            MONW(I,J)=MONTH(I+1,J-6) +6
            NWDAYS(I,J)=NDAYS(I+1,J-6)
            NWRH(I,J)=NRH(I+1,J-6)
            NWRX(I,J)=NRX(I+1,J-6)
            NWDX(I,J)=NDX(I+1,J-6)
            NWEV(I,J)=NEV(I+1,J-6)
            NWVD(I,J)=NVD(I+1,J-6)
            PCTRX(I,J)=PCTCRX(I+1,J-6)
            PCTVD(I,J)=PCTCVD(I+1,J-6)
  902     CONTINUE
        KPAGE=0
        IF(KWAT.EQ.1.AND.KQQ.EQ.1) CALL WATSUM(KQQ)
 1915   CONTINUE
          DO 1002 M=1,2
          IF (M.EQ.1) GOTO 1916
C         ----------
C         SEQUENCE MONTHS IN YEAR BASED ON MONTH WITH
C         GREATEST % OF TIME AS VIOLATION DAYS
C         ----------
          DO 904 I=1,NM1
            DO 904 J=1,11
              IP1=J+1
              DO 904 K=IP1,12
                IF(PCTVD(I,J).GE.PCTVD(I,K)) GO TO 904
                TEMP=PCTVD(I,J)
                PCTVD(I,J)=PCTVD(I,K)
                PCTVD(I,K)=TEMP
                NTEMP=MONW(I,J)
                MONW(I,J)=MONW(I,K)
                MONW(I,K)=NTEMP
                NTEMP=NWDAYS(I,J)
                NWDAYS(I,J)=NWDAYS(I,K)
                NWDAYS(I,K)=NTEMP
                NTEMP=NWRH(I,J)
                NWRH(I,J)=NWRH(I,K)
                NWRH(I,K)=NTEMP
                NTEMP=NWRX(I,J)
                NWRX(I,J)=NWRX(I,K)
```

Table A-6 (Continued)

```
                  NWRX(I,K)=NTEMP                                               MAIN601
                  NTEMP=NWDX(I,J)                                               MAIN602
                  NWDX(I,J)=NWDX(I,K)                                           MAIN603
                  NWDX(I,K)=NTEMP                                               MAIN604
                  NTEMP=NWEV(I,J)                                               MAIN605
                  NWEV(I,J)=NWEV(I,K)                                           MAIN606
                  NWEV(I,K)=NTEMP                                               MAIN607
                  TEMP=PCTRX(I,J)                                               MAIN608
                  PCTRX(I,J)=PCTRX(I,K)                                         MAIN609
                  PCTRX(I,K)=TEMP                                               MAIN610
                  NTEMP=NWVD(I,J)                                               MAIN611
                  NWVD(I,J)=NWVD(I,K)                                           MAIN612
                  NWVD(I,K)=NTEMP                                               MAIN613
  904           CONTINUE                                                        MAIN614
              KPAGE=0                                                           MAIN615
              IF(KSEQ.EQ.1.AND.KQQ.EQ.1) CALL WATSEQ(KQQ)                       MAIN616
 1916         CONTINUE                                                          MAIN617
              DO 905 I=1,NM1                                                    MAIN618
                NWYR(I)=0                                                       MAIN619
                NRYR(I)=0                                                       MAIN620
                NRXYR(I)=0                                                      MAIN621
                NEVYR(I)=0                                                      MAIN622
                NANNVD(I)=0                                                     MAIN623
                NWDXYR(I)=0                                                     MAIN624
  905           CONTINUE                                                        MAIN625
              DO 906 I=1,NM1                                                    MAIN626
                NWYR(I)=I                                                       MAIN627
                DO 906 J=1,12                                                   MAIN628
                  NRYR(I)=NRYR(I)+NWRH(I,J)                                     MAIN629
                  NRXYR(I)=NRXYR(I)+NWRX(I,J)                                   MAIN630
                  NEVYR(I)=NEVYR(I)+NWEV(I,J)                                   MAIN631
                  NANNVD(I)=NANNVD(I)+NWVD(I,J)                                 MAIN632
                  NWDXYR(I)=NWDXYR(I)+NWDX(I,J)                                 MAIN633
  906           CONTINUE                                                        MAIN634
              IF (M.EQ.1) GOTO 9071                                             MAIN635
C             ----------                                                        MAIN636
C             SEQUENCE WATER YEAR BY ANNUAL HOURS RAIN > 0.XX IN/HR             MAIN637
C             ----------                                                        MAIN638
              DO 907 I=1,NM2                                                    MAIN639
                IP1=I+1                                                         MAIN640
                DO 907 J=IP1,NM1                                                MAIN641
                  IF(NRXYR(I).GE.NRXYR(J)) GO TO 907                            MAIN642
                  NTEMP=NRXYR(I)                                                MAIN643
                  NRXYR(I)=NRXYR(J)                                             MAIN644
                  NRXYR(J)=NTEMP                                                MAIN645
                  NTEMP=NRYR(I)                                                 MAIN646
                  NRYR(I)=NRYR(J)                                               MAIN647
                  NRYR(J)=NTEMP                                                 MAIN648
                  NTEMP=NEVYR(I)                                                MAIN649
                  NEVYR(I)=NEVYR(J)                                             MAIN650
                  NEVYR(J)=NTEMP                                                MAIN651
                  NTEMP=NWYR(I)                                                 MAIN652
                  NWYR(I)=NWYR(J)                                               MAIN653
                  NWYR(J)=NTEMP                                                 MAIN654
                  NTEMP=NANNVD(I)                                               MAIN655
                  NANNVD(I)=NANNVD(J)                                           MAIN656
                  NANNVD(J)=NTEMP                                               MAIN657
                  NTEMP=NWDXYR(I)                                               MAIN658
                  NWDXYR(I)=NWDXYR(J)                                           MAIN659
                  NWDXYR(J)=NTEMP                                               MAIN660
```

Table A-6 (Continued)

```
              DO 9072 K=1,12                                MAIN661
                NTEMP=NWDX(I,K)                             MAIN662
                NWDX(I,K)=NWDX(J,K)                         MAIN663
                NWDX(J,K)=NTEMP                             MAIN664
 9072         CONTINUE                                      MAIN665
  907       CONTINUE                                        MAIN666
 9071     CONTINUE                                          MAIN667
C            ----------                                     MAIN668
C            BEGIN VARIABLE INITIALIZATION                  MAIN669
C            ----------                                     MAIN670
          DO 4001 I=1,43                                    MAIN671
            XTOT(I)=0.                                      MAIN672
            XAVG(I)=0.                                      MAIN673
            XSIG(I)=0.                                      MAIN674
            XSQ(I)=0.                                       MAIN675
            VMAX(I)=0.0                                     MAIN676
            VMIN(I)= 1000.0                                 MAIN677
            P95(I)=0.0                                      MAIN678
            P90(I)=0.0                                      MAIN679
            P85(I)=0.0                                      MAIN680
            P80(I)=0.0                                      MAIN681
            P75(I)=0.0                                      MAIN682
            P70(I)=0.0                                      MAIN683
            P65(I)=0.0                                      MAIN684
            P60(I)=0.0                                      MAIN685
            P55(I)=0.0                                      MAIN686
            P50(I)=0.0                                      MAIN687
            P45(I)=0.0                                      MAIN688
            P40(I)=0.0                                      MAIN689
            P35(I)=0.0                                      MAIN690
            P30(I)=0.0                                      MAIN691
            P25(I)=0.0                                      MAIN692
            P20(I)=0.0                                      MAIN693
            P15(I)=0.0                                      MAIN694
            P10(I)=0.0                                      MAIN695
            P5(I)=0.0                                       MAIN696
            Q95(I)=0.0                                      MAIN697
            Q90(I)=0.0                                      MAIN698
            Q85(I)=0.0                                      MAIN699
            Q80(I)=0.0                                      MAIN700
            Q75(I)=0.0                                      MAIN701
            Q70(I)=0.0                                      MAIN702
            Q65(I)=0.0                                      MAIN703
            Q60(I)=0.0                                      MAIN704
            Q55(I)=0.0                                      MAIN705
            Q50(I)=0.0                                      MAIN706
            Q45(I)=0.0                                      MAIN707
            Q40(I)=0.0                                      MAIN708
            Q35(I)=0.0                                      MAIN709
            Q30(I)=0.0                                      MAIN710
            Q25(I)=0.0                                      MAIN711
            Q20(I)=0.0                                      MAIN712
            Q15(I)=0.0                                      MAIN713
            Q10(I)=0.0                                      MAIN714
            Q5(I)=0.0                                       MAIN715
            L95(I)=0                                        MAIN716
            L90(I)=0                                        MAIN717
            L85(I)=0                                        MAIN718
            L80(I)=0                                        MAIN719
            L75(I)=0                                        MAIN720
```

Table A-6 (Continued)

```
        L70(I)=0
        L65(I)=0
        L60(I)=0
        L55(I)=0
        L50(I)=0
        L45(I)=0
        L40(I)=0
        L35(I)=0
        L30(I)=0
        L25(I)=0
        L20(I)=0
        L15(I)=0
        L10(I)=0
        L5(I)=0
 4001   CONTINUE
C        ----------
C        END OF VARIABLE INITIALIZATION
C        ----------
      DO 5001 I=1,NM1
        XTOT(1)=XTOT(1)+NRYR(I)
        XSQ(1)=XSQ(1)+(NRYR(I)*NRYR(I))
        IF(NRYR(I).GT.VMAX(1)) VMAX(1)=NRYR(I)
        IF(NRYR(I).LT.VMIN(1)) VMIN(1)=NRYR(I)
 5001   CONTINUE
      DO 5002 I=1,NM1
        XTOT(2)=XTOT(2)+NRXYR(I)
        XSQ(2)=XSQ(2)+(NRXYR(I)*NRXYR(I))
        IF(NRXYR(I).GT.VMAX(2)) VMAX(2)=NRXYR(I)
        IF(NRXYR(I).LT.VMIN(2)) VMIN(2)=NRXYR(I)
 5002   CONTINUE
      DO 5003 I=1,NM1
        XTOT(3)=XTOT(3)+NEVYR(I)
        XSQ(3)=XSQ(3)+(NEVYR(I)*NEVYR(I))
        IF(NEVYR(I).GT.VMAX(3)) VMAX(3)=NEVYR(I)
        IF(NEVYR(I).LT.VMIN(3)) VMIN(3)=NEVYR(I)
 5003   CONTINUE
      DO 5004 I=1,NM1
        XTOT(4)=XTOT(4)+NANNVD(I)
        XSQ(4)=XSQ(4)+(NANNVD(I)*NANNVD(I))
        IF(NANNVD(I).GT.VMAX(4)) VMAX(4)=NANNVD(I)
        IF(NANNVD(I).LT.VMIN(4)) VMIN(4)=NANNVD(I)
 5004   CONTINUE
      DO 5005 I=1,NM1
        XTOT(5)=XTOT(5)+NWRX(I,1)
        XSQ(5)=XSQ(5)+(NWRX(I,1)*NWRX(I,1))
        IF(NWRX(I,1).GT.VMAX(5)) VMAX(5)=NWRX(I,1)
        IF(NWRX(I,1).LT.VMIN(5)) VMIN(5)=NWRX(I,1)
 5005   CONTINUE
      DO 5006 I=1,NM1
        XTOT(6)=XTOT(6)+PCTRX(I,1)
        XSQ(6)=XSQ(6)+(PCTRX(I,1)*PCTRX(I,1))
        IF(PCTRX(I,1).GT.VMAX(6)) VMAX(6)=PCTRX(I,1)
        IF(PCTRX(I,1).LT.VMIN(6)) VMIN(6)=PCTRX(I,1)
 5006   CONTINUE
      DO 5007 I=1,NM1
        XTOT(7)=XTOT(7)+NWDXYR(I)
        XSQ(7)=XSQ(7)+(NWDXYR(I)*NWDXYR(I))
        IF(NWDXYR(I).GT.VMAX(7)) VMAX(7)=NWDXYR(I)
        IF(NWDXYR(I).LT.VMIN(7)) VMIN(7)=NWDXYR(I)
 5007   CONTINUE
```

Table A-6 (Continued)

```
          DO 5008 J=1,12                                                MAIN781
            DO 5008 I=1,NM1                                             MAIN782
              XTOT(J+7)=XTOT(J+7)+NWVD(NWYR(I),J)                       MAIN783
              XSQ(J+7)=XSQ(J+7)+(NWVD(NWYR(I),J)*NWVD(NWYR(I),J))       MAIN784
              IF(NWVD(NWYR(I),J).GT.VMAX(J+7)) VMAX(J+7)=NWVD(NWYR(I),J)MAIN785
              IF(NWVD(NWYR(I),J).LT.VMIN(J+7)) VMIN(J+7)=NWVD(NWYR(I),J)MAIN786
5008        CONTINUE                                                    MAIN787
          DO 5009 J=1,12                                                MAIN788
            DO 5009 I=1,NM1                                             MAIN789
              XTOT(J+19)=XTOT(J+19)+PCTVD(NWYR(I),J)                    MAIN790
              XSQ(J+19)=XSQ(J+19)+(PCTVD(NWYR(I),J)*PCTVD(NWYR(I),J))   MAIN791
              IF(PCTVD(NWYR(I),J).GT.VMAX(J+19))                        MAIN792
     @          VMAX(J+19)=PCTVD(NWYR(I),J)                             MAIN793
              IF(PCTVD(NWYR(I),J).LT.VMIN(J+19))                        MAIN794
     @          VMIN(J+19)=PCTVD(NWYR(I),J)                             MAIN795
5009        CONTINUE                                                    MAIN796
          DO 5011 J=1,12                                                MAIN797
            DO 5011 I=1,NM1                                             MAIN798
              XTOT(J+31)=XTOT(J+31)+NWDX(I,J)                           MAIN799
              XSQ(J+31)=XSQ(J+31)+(NWDX(I,J)*NWDX(I,J))                 MAIN800
              IF(NWDX(I,J).GT.VMAX(J+31)) VMAX(J+31)=NWDX(I,J)          MAIN801
              IF(NWDX(I,J).LT.VMIN(J+31)) VMIN(J+31)=NWDX(I,J)          MAIN802
5011        CONTINUE                                                    MAIN803
          DO 5010 I=1,43                                                MAIN804
      ABC=FLOAT(NM1)                                                    MAIN805
      ABD=FLOAT(NM2)                                                    MAIN806
            XAVG(I)=(XTOT(I))/ABC                                       MAIN807
            XSIG(I)=SQRT((XSQ(I)-((XTOT(I)*XTOT(I))/ABC))/ABD)          MAIN808
            P95(I)=XAVG(I)+CSTAT( 1)*XSIG(I)                            MAIN809
            P90(I)=XAVG(I)+CSTAT( 2)*XSIG(I)                            MAIN810
            P85(I)=XAVG(I)+CSTAT( 3)*XSIG(I)                            MAIN811
            P80(I)=XAVG(I)+CSTAT( 4)*XSIG(I)                            MAIN812
            P75(I)=XAVG(I)+CSTAT( 5)*XSIG(I)                            MAIN813
            P70(I)=XAVG(I)+CSTAT( 6)*XSIG(I)                            MAIN814
            P65(I)=XAVG(I)+CSTAT( 7)*XSIG(I)                            MAIN815
            P60(I)=XAVG(I)+CSTAT( 8)*XSIG(I)                            MAIN816
            P55(I)=XAVG(I)+CSTAT( 9)*XSIG(I)                            MAIN817
            P50(I)=XAVG(I)+CSTAT(10)*XSIG(I)                            MAIN818
            P45(I)=XAVG(I)+CSTAT(11)*XSIG(I)                            MAIN819
            P40(I)=XAVG(I)+CSTAT(12)*XSIG(I)                            MAIN820
            P35(I)=XAVG(I)+CSTAT(13)*XSIG(I)                            MAIN821
            P30(I)=XAVG(I)+CSTAT(14)*XSIG(I)                            MAIN822
            P25(I)=XAVG(I)+CSTAT(15)*XSIG(I)                            MAIN823
            P20(I)=XAVG(I)+CSTAT(16)*XSIG(I)                            MAIN824
            P15(I)=XAVG(I)+CSTAT(17)*XSIG(I)                            MAIN825
            P10(I)=XAVG(I)+CSTAT(18)*XSIG(I)                            MAIN826
             P5(I)=XAVG(I)+CSTAT(19)*XSIG(I)                            MAIN827
5010        CONTINUE                                                    MAIN828
          CALL CALC                                                     MAIN829
          CALL PRINT(KQQ,M)                                             MAIN830
1002    CONTINUE                                                        MAIN831
      IF(KWGS.LE.1000) GO TO 1999                                       MAIN832
      WRITE(N6,7060) TITLE                                              MAIN833
      WRITE(N6,7081) MOSTAR,DSTART,ISTART                               MAIN834
      IF(ISTART.LT.10) WRITE(N6,7082)                                   MAIN835
      WRITE(N6,7083) MOSTOP,DSTOP,ISTOP                                 MAIN836
      IF(ISTOP.LT.10) WRITE(N6,7082)                                    MAIN837
      WRITE(N6,7084) X,Y,NIN,NYL1,KSUM,KWAT,KSEQ,KWGS                   MAIN838
      WRITE(N6,7080) CB,BMULT,Y,ALPHA,BETA                              MAIN839
      WRITE(N6,620)                                                     MAIN840
```

Table A-6 (Continued)

```
  620 FORMAT(1H0,//5X,22HPROGRAM ENDED NORMALLY)
      STOP
      END
C ======================================================================
      SUBROUTINE SUMM(KQQ)
      COMMON/BLK2/  NDX(70,12),NEV(70,12),NRH(70,12),NRX(70,12),
     @              NVD(70,12),MONTH(70,12),NDAYS(70,12),NCALYR(70,12)
      INTEGER*2 NDX,NEV,NRH,NRX,NVD.MONTH,NDAYS,NCALYR
      COMMON/BLK3/  PCTCRX(70,12),PCTCVD(70,12)
      COMMON/BLK4/  KPAGE
      COMMON/BLK5/  X,N5,N6
      COMMON/BLK16/ BMON(12)
      COMMON/BLK22/ NYEARS,NM1,NM2
C     ----------
C     WRITE SUMMARY TABLE
C     ----------
      WRITE(N6,605)
  605 FORMAT(1H1,50X,13HSUMMARY TABLE/)
      WRITE(N6,653) X,X,X
  653 FORMAT(
     @ //,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF     OVFLOW       AS'/,
     @ T11,'CAL. ',T20,9('-'),T33,'IN     WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL     MGAL',
     @ T66,'EVENTS     DAYS       MGAL       DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
      DO 995 I=1,NYEARS
      DO 995 J=1,12
      WRITE(N6,610) NCALYR(I,J),MONTH(I,J),BMON(J),NDAYS(I,J),NRH(I,J),
     @             NRX(I,J),NDX(I,J),NEV(I,J),NVD(I,J),PCTCRX(I,J),
     @             PCTCVD(I,J)
  610 FORMAT(T12,I4,I7,3X,A3,I7,2I8,2I9,I10,2X,2F10.1)
      KPAGE=KPAGE+1
      IF(((KPAGE/42)*42).EQ.KPAGE) WRITE(N6,651) X,X,X
  651 FORMAT(1H1,T44,'SUMMARY TABLE (CONTINUED)'
     @ //,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF     OVFLOW       AS'/,
     @ T11,'CAL. ',T20,9('-'),T33,'IN     WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL     MGAL',
     @ T66,'EVENTS     DAYS       MGAL       DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
  995 CONTINUE
      RETURN
      END
C ======================================================================
      SUBROUTINE WATSUM(KQQ)
      COMMON/BLK3/  PCTCRX(70,12),PCTCVD(70,12)
      COMMON/BLK4/  KPAGE
      COMMON/BLK5/  X,N5,N6
      COMMON/BLK6/  NWEV(70,12),NWRH(70,12),NWATYR(70,12),NWDAYS(70,12)
      INTEGER*2 NWEV,NWRH,NWATYR,NWDAYS
      COMMON/BLK7/  NWDX(70,12),NWRX(70,12),NWVD(70,12)
```

Table A-6 (Continued)

```
      INTEGER*2 NWDX,NWRX,NWVD
      COMMON/BLK8/  MONW(70,12)
      INTEGER*2 MONW
      COMMON/BLK17/ AMON(12)
      COMMON/BLK22/ NYEARS,NM1,NM2
C     ----------
C     WRITE WATER YEAR SUMMARY TABLE
C     ----------
      WRITE(N6,630)
  630 FORMAT(1H1,45X,'WATER YEAR SUMMARY TABLE'/)
      WRITE(N6,654) X,X,X
  654 FORMAT(
     @ //,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF     OVFLOW        AS'/,
     @ T11,'WATER',T20,9('-'),T33,'IN     WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL     MGAL',
     @ T66,'EVENTS     DAYS       MGAL        DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
      DO 915 I=1,NYEARS
        DO 915 J=1,12
  610     FORMAT(T12,I4,I7,3X,A3,I7,2I8,2I9,I10,2X,2F10.1)
          WRITE(N6,610) NWATYR(I,J),MONW(I,J),AMON(J),NWDAYS(I,J),
     @          NWRH(I,J),NWRX(I,J),NWDX(I,J),NWEV(I,J),NWVD(I,J)
     @          ,PCTCRX(I,J),PCTCVD(I,J)
          KPAGE=KPAGE+1
          IF(((KPAGE/42)*42).EQ.KPAGE) WRITE(N6,652) X,X,X
  652     FORMAT(1H1,T39,'WATER YEAR SUMMARY TABLE (CONTINUED)'
     @ //,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF     OVFLOW        AS'/,
     @    T11,'WATER',T20,9('-'),T33,'IN     WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL     MGAL',
     @ T66,'EVENTS     DAYS       MGAL        DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
  915   CONTINUE
      RETURN
      END
C ====================================================================
      SUBROUTINE WATSEQ(KQQ)
      COMMON/BLK4/  KPAGE
      COMMON/BLK5/  X,N5,N6
      COMMON/BLK6/  NWEV(70,12),NWRH(70,12),NWATYR(70,12),NWDAYS(70,12)
      INTEGER*2 NWEV,NWRH,NWATYR,NWDAYS
      COMMON/BLK7/  NWDX(70,12),NWRX(70,12),NWVD(70,12)
      INTEGER*2 NWDX,NWRX,NWVD
      COMMON/BLK8/  MONW(70,12)
      INTEGER*2 MONW
      COMMON/BLK9/  PCTRX(70,12),PCTVD(70,12)
      COMMON/BLK17/ AMON(12)
      COMMON/BLK22/ NYEARS,NM1,NM2
C     ----------
C     WRITE SEQUENCED WATER YEAR SUMMARY TABLE
C     ----------
```

Table A-6 (Continued)

```
      WRITE(N6,631)
  631 FORMAT(1H1,T40,'SEQUENCED WATER YEAR SUMMARY TABLE'/)
  654 FORMAT(
     @ //,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF      OVFLOW        AS'/,
     @ T11,'WATER',T20,9('-'),T33,'IN      WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL      MGAL',
     @ T66,'EVENTS     DAYS        MGAL        DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
      WRITE(N6,654) X,X,X
      DO 916 I=1,NM1
        DO 916 J=1,12
  610     FORMAT(T12,I4,I7,3X,A3,I7,2I8,2I9,I10,2X,2F10.1)
          WRITE(N6,610)NWATYR(I,J),MONW(I,J),AMON(MONW(I,J)),NWDAYS(I,J)
     @         ,NWRH(I,J),NWRX(I,J),NWDX(I,J),NWEV(I,J),NWVD(I,J),
     @         PCTRX(I,J),PCTVD(I,J)
          KPAGE=KPAGE+1
          IF(((KPAGE/42)*42).EQ.KPAGE) WRITE(N6,656) X,X,X
  656     FORMAT(1H1,T34,'SEQUENCED WATER YEAR SUMMARY TABLE (CONTINUED)
     @ '//,T48,'HOURS',T58,'DAYS',T88,'% OF',T99,'% OF'/,
     @ T48,'WITH',T58,'WITH',T88,'TIME',T98,'MONTH'/,
     @ T22,'MONTH     DAYS    HOURS   OVFLOW   OVFLOW',
     @ T66,'NO. OF    NO. OF      OVFLOW        AS'/,
     @     T11,'WATER',T20,9('-'),T33,'IN      WITH    > ',F4.2,T57,'> ',
     @ F4.2,T66,'OVFLOW   VIOLATION   > ',F4.2,T96,'VIOLATION'/,
     @ T11, 'YEAR     NO.  NAME   MONTH   OFLOW    MGAL      MGAL',
     @ T66,'EVENTS     DAYS        MGAL        DAYS'/,
     @ T11,5('-'),T20,'---  ----   -----   -----   ------   ------',
     @ T66,'------   ---------   ------   ---------'/)
  916   CONTINUE
      RETURN
      END
C ======================================================================
      SUBROUTINE PRINT(KQQ,M)
      COMMON/BLK5/  X,N5,N6
      COMMON/BLK7/  NWDX(70,12),NWRX(70,12),NWVD(70,12)
      INTEGER*2 NWDX,NWRX,NWVD
      COMMON/BLK8/  MONW(70,12)
      INTEGER*2 MONW
      COMMON/BLK9/  PCTRX(70,12),PCTVD(70,12)
      COMMON/BLK11/ NRYR(70),NWYR(70),NEVYR(70),NRXYR(70),NANNVD(70),
     @              NWDXYR(70)
      INTEGER*2 NRYR,NWYR,NEVYR,NRXYR,NANNVD,NWDXYR
      COMMON/BLK12/ L95(43),L90(43),L85(43),L80(43),L75(43),
     @              L70(43),L65(43),L60(43),L55(43),L50(43),L45(43),
     @              L40(43),L35(43),L30(43),L25(43),L20(43),L15(43),
     @              L10(43),L5(43)
      INTEGER*2 L95,L90,L85,L80,L75,L70,L65,L60,L55,L50,L45,L40,L35,
     @          L30,L25,L20,L15,L10,L5
      COMMON/BLK13/ Q95(43),Q90(43),Q85(43),Q80(43),Q75(43),
     @              Q70(43),Q65(43),Q60(43),Q55(43),Q50(43),Q45(43),
     @              Q40(43),Q35(43),Q30(43),Q25(43),Q20(43),Q15(43),
     @              Q10(43),Q5(43)
      COMMON/BLK14/ XTOT(43),XAVG(43),XSIG(43),VMAX(43),VMIN(43),
     @              P95(43),P90(43),P85(43),P80(43),P75(43),P70(43),
     @              P65(43),P60(43),P55(43),P50(43),P45(43),P40(43),
```

Table A-6 (Continued)

```
     @           P35(43),P30(43),P25(43),P20(43),P15(43),P10(43),
     @           P5(43),NYL1
      COMMON/BLK17/ AMON(12)
      COMMON/BLK22/ NYEARS,NM1,NM2
C     ----------
C     WRITE RAINFALL CHARACTERIZATION TABLE
C     ----------
      WRITE(N6,6201)
      IF (KQQ.EQ.1) WRITE(N6,6200)
      IF (KQQ.EQ.2) WRITE(N6,6220)
      IF (KQQ.EQ.3) WRITE(N6,6240)
      IF (KQQ.EQ.4) WRITE(N6,6260)
      IF (KQQ.EQ.5) WRITE(N6,6280)
 6201 FORMAT(1H1,10X,31HANNUAL OVERFLOW CHARACTERISTICS)
 6200 FORMAT(1H+,44X,'--  BODY CONTACT RECREATION --  EVENTS GREATER',
     @        ' THAN 10,000 MPN/100 ML')
 6220 FORMAT(1H+,44X,'--  BODY CONTACT RECREATION --  5-DAY MEDIAN',
     @        ' GREATER THAN 240 MPN/100 ML')
 6240 FORMAT(1H+,44X,'-- SHELLFISH --  30-DAY MEDIAN GREATER THAN',
     @        ' 70 MPN/100 ML')
 6260 FORMAT(1H+,44X,'-- SHELLFISH -- 30-DAY TEN PERCENTILE GREATER',
     @        ' THAN 230 MPN/100 ML')
 6280 FORMAT(1H+,44X,'--  BODY CONTACT RECREATION --  30-DAY TWENTY',
     @        ' PERCENTILE GREATER THAN 1,000 MPN/100 ML')
      IF(M.EQ.1) WRITE(N6,6291)
      IF(M.EQ.2) WRITE(N6,6292) X
 6291 FORMAT(1H0,T2,'(CHRONOLOGICAL ORDER BY WATER YEAR)')
 6292 FORMAT(1H0,T2,'(RANKED BY ANNUAL HOURS OVERFLOW GREATER THAN ',
     @       F4.2,' MGAL )')
 6293 FORMAT(1H0,T2,'(PERCENTILES BASED ON ASSUMED ARITHMETIC DISTRIBUTI
     @ON)')
 6294 FORMAT(1H0,T2,'(PERCENTILES BASED ON RANKED VALUES)')
      IF(M.EQ.1) WRITE(N6,691)X,X,X,X,X
      IF(M.EQ.2) WRITE(N6,6911)X,X,X,X,X
  691 FORMAT(1H0,T2,130('-'),/,
     @ T40,'1ST MONTH'/,T34,21('-')/,
     @ T14,'ANN',T47,'% OF HRS'/,T14,'HOURS',T40,'HOURS IN MONTH'
     @,T60,8HANN DAYS,T90,'DAYS OVERFLOW > ',F4.2,' MGAL',/,
     @ T8,'ANN   OVFL   ANN   ANN',T40,'OVFL     OVFL'
     @,T62,4HOVFL,T70,60(1H-),/,
     @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',5X,2('   > ',F4.2)
     @,T61,1H>,F5.2,T97,'MONTH',/,
     @ T2,'YEAR  HRS   MGAL  EVENTS DAYS   MON   MGAL     MGAL',9X,'MGAL
     @'   ,T72,'JUL  AUG  SEP  OCT  NOV  DEC  JAN  FEB  MAR  APR  MAY',
     @ '  JUN',/,
     @ T2,'----- ---- ------ ------ ----   ---  ------  --------'
     @,T60,8(1H-),T70,12(2X,3H---),/)
 6911 FORMAT(1H0,T2,53('-'),/,
     @ T40,'1ST MONTH'/,T34,21('-')/,
     @ T14,'ANN',T47,'% OF HRS'/,T14,'HOURS',T40,'HOURS IN MONTH'
     @,T60,8HANN DAYS,T90,'DAYS OVERFLOW > ',F4.2,' MGAL',/,
     @ T8,'ANN   OVFL   ANN   ANN',T40,'OVFL     OVFL'
     @,T62,4HOVFL,T70,60(1H-),/,
     @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',5X,2('   > ',F4.2)
     @,T61,1H>,F5.2,T97,'MONTH',/,
     @ T2,'YEAR  HRS   MGAL  EVENTS DAYS   MON   MGAL     MGAL',9X,'MGAL
     @'   ,T72,' 1    2    3    4    5    6    7    8    9    10   11',
     @ '   12',/,
     @ T2,'----- ---- ------ ------ ----   ---  ------  --------'
     @,T60,8(1H-),T70,12(2X,3H---),/)
```

Table A-6 (Continued)

```
      DO 910 I=1,NM1
        NYPRT=NWYR(I)+NYL1+1900-1
        K=MONW(NWYR(I),1)
        WRITE(N6,692) NYPRT,NRYR(I),NRXYR(I),NEVYR(I),NANNVD(I),
     @              AMON(K),NWRX(NWYR(I),1),PCTRX(NWYR(I),1)
     @             ,NWDXYR(I),(NWDX(I,J),J=1,12)
 692    FORMAT(T2,I4,3I6,I7,3X,A3,I7,F10.1,I11,5X,12I5)
        IF (I.EQ.40) WRITE(N6,6201)
        IF (I.EQ.40.AND.KQQ.EQ.1) WRITE(N6,6200)
        IF (I.EQ.40.AND.KQQ.EQ.2) WRITE(N6,6220)
        IF (I.EQ.40.AND.KQQ.EQ.3) WRITE(N6,6240)
        IF (I.EQ.40.AND.KQQ.EQ.4) WRITE(N6,6260)
        IF (I.EQ.40.AND.KQQ.EQ.5) WRITE(N6,6280)
        IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,6291)
        IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,6292) X
        IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,691)X,X,X,X,X
        IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,6911)X,X,X,X,X
 910    CONTINUE
      DO 101 K=1,2
        WRITE(N6,6201)
        IF(KQQ.EQ.1) WRITE(N6,6200)
        IF(KQQ.EQ.2) WRITE(N6,6220)
        IF(KQQ.EQ.3) WRITE(N6,6240)
        IF(KQQ.EQ.4) WRITE(N6,6260)
        IF(KQQ.EQ.5) WRITE(N6,6280)
        IF(M.EQ.1) WRITE(N6,6291)
        IF(M.EQ.2) WRITE(N6,6292) X
        IF(K.EQ.1) WRITE(N6,6293)
        IF(K.EQ.2) WRITE(N6,6294)
        IF(M.EQ.1) WRITE(N6,691)X,X,X,X,X
        IF(M.EQ.2) WRITE(N6,6911)X,X,X,X,X
        WRITE(N6,6001)(XTOT(I),I=1,7),(XTOT(I),I=32,43),
     @             (XAVG(I),I=1,7),(XAVG(I),I=32,43),
     @             (XSIG(I),I=1,7),(XSIG(I),I=32,43),
     @             (VMAX(I),I=1,7),(VMAX(I),I=32,43),
     @             (VMIN(I),I=1,7),(VMIN(I),I=32,43)
        IF(K.EQ.2) GO TO 102
        WRITE(N6,681) (P95(I),I=1,7),(P95(I),I=32,43),
     @             (P90(I),I=1,7),(P90(I),I=32,43),
     @             (P85(I),I=1,7),(P85(I),I=32,43),
     @             (P80(I),I=1,7),(P80(I),I=32,43),
     @             (P75(I),I=1,7),(P75(I),I=32,43),
     @             (P70(I),I=1,7),(P70(I),I=32,43),
     @             (P65(I),I=1,7),(P65(I),I=32,43),
     @             (P60(I),I=1,7),(P60(I),I=32,43),
     @             (P55(I),I=1,7),(P55(I),I=32,43),
     @             (P50(I),I=1,7),(P50(I),I=32,43)
        WRITE(N6,682) (P45(I),I=1,7),(P45(I),I=32,43),
     @             (P40(I),I=1,7),(P40(I),I=32,43),
     @             (P35(I),I=1,7),(P35(I),I=32,43),
     @             (P30(I),I=1,7),(P30(I),I=32,43),
     @             (P25(I),I=1,7),(P25(I),I=32,43),
     @             (P20(I),I=1,7),(P20(I),I=32,43),
     @             (P15(I),I=1,7),(P15(I),I=32,43),
     @             (P10(I),I=1,7),(P10(I),I=32,43),
     @             ( P5(I),I=1,7),( P5(I),I=32,43)
        GO TO 101
 102    WRITE(N6,6811)(L95(I),I=1,5),Q95(6),L95(7),(L95(I),I=32,43),
     @             (L90(I),I=1,5),Q90(6),L90(7),(L90(I),I=32,43),
     @             (L85(I),I=1,5),Q85(6),L85(7),(L85(I),I=32,43),
```

Table A-6 (Continued)

```
      @              (L80(I),I=1,5),Q80(6),L80(7),(L80(I),I=32,43),      PRIN145
      @              (L75(I),I=1,5),Q75(6),L75(7),(L75(I),I=32,43),      PRIN146
      @              (L70(I),I=1,5),Q70(6),L70(7),(L70(I),I=32,43),      PRIN147
      @              (L65(I),I=1,5),Q65(6),L65(7),(L65(I),I=32,43),      PRIN148
      @              (L60(I),I=1,5),Q60(6),L60(7),(L60(I),I=32,43),      PRIN149
      @              (L55(I),I=1,5),Q55(6),L55(7),(L55(I),I=32,43),      PRIN150
      @              (L50(I),I=1,5),Q50(6),L50(7),(L50(I),I=32,43)       PRIN151
       WRITE(N6,6821)(L45(I),I=1,5),Q45(6),L45(7),(L45(I),I=32,43),      PRIN152
      @              (L40(I),I=1,5),Q40(6),L40(7),(L40(I),I=32,43),      PRIN153
      @              (L35(I),I=1,5),Q35(6),L35(7),(L35(I),I=32,43),      PRIN154
      @              (L30(I),I=1,5),Q30(6),L30(7),(L30(I),I=32,43),      PRIN155
      @              (L25(I),I=1,5),Q25(6),L25(7),(L25(I),I=32,43),      PRIN156
      @              (L20(I),I=1,5),Q20(6),L20(7),(L20(I),I=32,43),      PRIN157
      @              (L15(I),I=1,5),Q15(6),L15(7),(L15(I),I=32,43),      PRIN158
      @              (L10(I),I=1,5),Q10(6),L10(7),(L10(I),I=32,43),      PRIN159
      @              ( L5(I),I=1,5), Q5(6), L5(7),( L5(I),I=32,43)       PRIN160
 6001  FORMAT(//,T2,4HTOT ,3F6.0,F7.0,6X,F7.0,F10.1,F11.0,5X,12(F5.0), PRIN161
      @       //,T2,4HAVG ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1), PRIN162
      @       //,T2,4HSIG ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1), PRIN163
      @       //T2,4HMAX ,3F6.0,F7.0,6X,F7.0,F10.1,F11.0,5X,12(F5.0),  PRIN164
      @       //T2,4HMIN ,3F6.0,F7.0,6X,F7.0,F10.1,F11.0,5X,12(F5.0))  PRIN165
 681   FORMAT(//T2,4H95% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN166
      @        /T2,4H90% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN167
      @        /T2,4H85% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN168
      @        /T2,4H80% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN169
      @        /T2,4H75% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN170
      @        /T2,4H70% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN171
      @        /T2,4H65% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN172
      @        /T2,4H60% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN173
      @        /T2,4H55% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN174
      @        /T2,4H50% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1))  PRIN175
 682   FORMAT(  T2,4H45% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN176
      @        /T2,4H40% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN177
      @        /T2,4H35% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN178
      @        /T2,4H30% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN179
      @        /T2,4H25% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN180
      @        /T2,4H20% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN181
      @        /T2,4H15% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN182
      @        /T2,4H10% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1),  PRIN183
      @        /T2,4H 5% ,3F6.1,F7.1,6X,F7.1,F10.1,F11.1,5X,12(F5.1))  PRIN184
 6811  FORMAT(//T2,4H95% ,3I6.I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN185
      @        /T2,4H90% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN186
      @        /T2,4H85% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN187
      @        /T2,4H80% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN188
      @        /T2,4H75% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN189
      @        /T2,4H70% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN190
      @        /T2,4H65% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN191
      @        /T2,4H60% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN192
      @        /T2,4H55% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN193
      @        /T2,4H50% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5))            PRIN194
 6821  FORMAT(  T2,4H45% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN195
      @        /T2,4H40% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN196
      @        /T2,4H35% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN197
      @        /T2,4H30% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN198
      @        /T2,4H25% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN199
      @        /T2,4H20% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN200
      @        /T2,4H15% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN201
      @        /T2,4H10% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5),            PRIN202
      @        /T2,4H 5% ,3I6,I7,6X,I7,F10.1,I11,5X,12(I5))            PRIN203
 101   CONTINUE                                                          PRIN204
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Table A-6 (Continued)

```
      WRITE(N6,6201)                                                    PRIN205
      IF (KQQ.EQ.1) WRITE(N6,6200)                                      PRIN206
      IF (KQQ.EQ.2) WRITE(N6,6220)                                      PRIN207
      IF (KQQ.EQ.3) WRITE(N6,6240)                                      PRIN208
      IF (KQQ.EQ.4) WRITE(N6,6260)                                      PRIN209
      IF (KQQ.EQ.5) WRITE(N6,6280)                                      PRIN210
      IF(M.EQ.1) WRITE(N6,6291)                                         PRIN211
      IF(M.EQ.2) WRITE(N6,6292) X                                       PRIN212
      IF(M.EQ.1) WRITE(N6,6931) X                                       PRIN213
      IF(M.EQ.2) WRITE(N6,693) X                                        PRIN214
  693 FORMAT(1H0,                                                       PRIN215
     @ T2,131('-')//,T14,'HOURS',T36,'1ST MONTH',T53,'2ND MONTH',T70,   PRIN216
     @ '3RD MONTH',T87,'4TH MONTH',T104,'5TH MONTH',T121,'6TH MONTH'/,  PRIN217
     @ T14,'OVFL   ANN   ANN',T31,6('   --------------')/,             PRIN218
     @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',T31,                   PRIN219
     @ 6('        VIOL  % OF')/,                                        PRIN220
     @ T2,'YEAR  HRS   MGAL  EVENTS DAYS',T31,                          PRIN221
     @ 6('   MON DAYS MONTH')/,                                         PRIN222
     @ T2,'----- ---- ------ ------ ----',T31,                          PRIN223
     @ 6('   --- ---- -----')/)                                         PRIN224
 6931 FORMAT(1H0,                                                       PRIN225
     @ T2,131('-')//,T14,'HOURS',T36,'   JUL   ',T53,'   AUG   ',T70,   PRIN226
     @ '   SEP   ',T87,'   OCT   ',T104,'   NOV   ',T121,'   DEC   '/,  PRIN227
     @ T14,'OVFL   ANN   ANN',T31,6('   --------------')/,             PRIN228
     @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',T31,                   PRIN229
     @ 6('        VIOL  % OF')/,                                        PRIN230
     @ T2,'YEAR  HRS   MGAL  EVENTS DAYS',T31,                          PRIN231
     @ 6('   MON DAYS MONTH')/,                                         PRIN232
     @ T2,'----- ---- ------ ------ ----',T31,                          PRIN233
     @ 6('   --- ---- -----')/)                                         PRIN234
      DO 911 I=1,NM1                                                    PRIN235
        NYPRT=NWYR(I)+NYL1+1900-1                                       PRIN236
        K1=MONW(NWYR(I),1)                                              PRIN237
        K2=MONW(NWYR(I),2)                                              PRIN238
        K3=MONW(NWYR(I),3)                                              PRIN239
        K4=MONW(NWYR(I),4)                                              PRIN240
        K5=MONW(NWYR(I),5)                                              PRIN241
        K6=MONW(NWYR(I),6)                                              PRIN242
        WRITE(N6,694) NYPRT,NRYR(I),NRXYR(I),NEVYR(I),NANNVD(I),        PRIN243
     @        AMON(K1),NWVD(NWYR(I), 1),PCTVD(NWYR(I), 1),              PRIN244
     @        AMON(K2),NWVD(NWYR(I), 2),PCTVD(NWYR(I), 2),              PRIN245
     @        AMON(K3),NWVD(NWYR(I), 3),PCTVD(NWYR(I), 3),              PRIN246
     @        AMON(K4),NWVD(NWYR(I), 4),PCTVD(NWYR(I), 4),              PRIN247
     @        AMON(K5),NWVD(NWYR(I), 5),PCTVD(NWYR(I), 5),              PRIN248
     @        AMON(K6),NWVD(NWYR(I), 6),PCTVD(NWYR(I), 6)               PRIN249
  694   FORMAT(T2,I4,3I6,I7,6(3X,A3,I4,F7.1))                           PRIN250
        IF (I.EQ.40) WRITE(N6,6201)                                     PRIN251
        IF (I.EQ.40.AND.KQQ.EQ.1) WRITE(N6,6200)                        PRIN252
        IF (I.EQ.40.AND.KQQ.EQ.2) WRITE(N6,6220)                        PRIN253
        IF (I.EQ.40.AND.KQQ.EQ.3) WRITE(N6,6240)                        PRIN254
        IF (I.EQ.40.AND.KQQ.EQ.4) WRITE(N6,6260)                        PRIN255
        IF (I.EQ.40.AND.KQQ.EQ.5) WRITE(N6,6280)                        PRIN256
        IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,6291)                           PRIN257
        IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,6292) X                         PRIN258
        IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,6931) X                         PRIN259
        IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,693 ) X                         PRIN260
  911   CONTINUE                              \                         PRIN261
      DO 103 K=1,2                                                      PRIN262
        WRITE(N6,6201)                                                  PRIN263
        IF (KQQ.EQ.1) WRITE(N6,6200)                                    PRIN264
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Table A-6 (Continued)

```
      IF (KQQ.EQ.2) WRITE(N6,6220)                                      PRIN265
      IF (KQQ.EQ.3) WRITE(N6,6240)                                      PRIN266
      IF (KQQ.EQ.4) WRITE(N6,6260)                                      PRIN267
      IF (KQQ.EQ.5) WRITE(N6,6280)                                      PRIN268
      IF(M.EQ.1) WRITE(N6,6291)                                         PRIN269
      IF(M.EQ.2) WRITE(N6,6292) X                                       PRIN270
      IF(K.EQ.1) WRITE(N6,6293)                                         PRIN271
      IF(K.EQ.2) WRITE(N6,6294)                                         PRIN272
      IF(M.EQ.1) WRITE(N6,6931) X                                       PRIN273
      IF(M.EQ.2) WRITE(N6,693) X                                        PRIN274
      WRITE(N6,6002)(XTOT(I),I=1,4),(XTOT(I),XTOT(I+12),I=8,13),        PRIN275
     @              (XAVG(I),I=1,4),(XAVG(I),XAVG(I+12),I=8,13),        PRIN276
     @              (XSIG(I),I=1,4),(XSIG(I),XSIG(I+12),I=8,13),        PRIN277
     @              (VMAX(I),I=1,4),(VMAX(I),VMAX(I+12),I=8,13),        PRIN278
     @              (VMIN(I),I=1,4),(VMIN(I),VMIN(I+12),I=8,13)         PRIN279
      IF(K.EQ.2) GO TO 104                                              PRIN280
      WRITE(N6,683) ( P95(I),I=1,4),( P95(I), P95(I+12),I=8,13),        PRIN281
     @              ( P90(I),I=1,4),( P90(I), P90(I+12),I=8,13),        PRIN282
     @              ( P85(I),I=1,4),( P85(I), P85(I+12),I=8,13),        PRIN283
     @              ( P80(I),I=1,4),( P80(I), P80(I+12),I=8,13),        PRIN284
     @              ( P75(I),I=1,4),( P75(I), P75(I+12),I=8,13),        PRIN285
     @              ( P70(I),I=1,4),( P70(I), P70(I+12),I=8,13),        PRIN286
     @              ( P65(I),I=1,4),( P65(I), P65(I+12),I=8,13),        PRIN287
     @              ( P60(I),I=1,4),( P60(I), P60(I+12),I=8,13),        PRIN288
     @              ( P55(I),I=1,4),( P55(I), P55(I+12),I=8,13),        PRIN289
     @              ( P50(I),I=1,4),( P50(I), P50(I+12),I=8,13)         PRIN290
      WRITE(N6,684) ( P45(I),I=1,4),( P45(I), P45(I+12),I=8,13),        PRIN291
     @              ( P40(I),I=1,4),( P40(I), P40(I+12),I=8,13),        PRIN292
     @              ( P35(I),I=1,4),( P35(I), P35(I+12),I=8,13),        PRIN293
     @              ( P30(I),I=1,4),( P30(I), P30(I+12),I=8,13),        PRIN294
     @              ( P25(I),I=1,4),( P25(I), P25(I+12),I=8,13),        PRIN295
     @              ( P20(I),I=1,4),( P20(I), P20(I+12),I=8,13),        PRIN296
     @              ( P15(I),I=1,4),( P15(I), P15(I+12),I=8,13),        PRIN297
     @              ( P10(I),I=1,4),( P10(I), P10(I+12),I=8,13),        PRIN298
     @              (  P5(I),I=1,4),(  P5(I),  P5(I+12),I=8,13)         PRIN299
      GO TO 103                                                         PRIN300
  104 WRITE(N6,6831)( L95(I),I=1,4),( L95(I), Q95(I+12),I=8,13),        PRIN301
     @              ( L90(I),I=1,4),( L90(I), Q90(I+12),I=8,13),        PRIN302
     @              ( L85(I),I=1,4),( L85(I), Q85(I+12),I=8,13),        PRIN303
     @              ( L80(I),I=1,4),( L80(I), Q80(I+12),I=8,13),        PRIN304
     @              ( L75(I),I=1,4),( L75(I), Q75(I+12),I=8,13),        PRIN305
     @              ( L70(I),I=1,4),( L70(I), Q70(I+12),I=8,13),        PRIN306
     @              ( L65(I),I=1,4),( L65(I), Q65(I+12),I=8,13),        PRIN307
     @              ( L60(I),I=1,4),( L60(I), Q60(I+12),I=8,13),        PRIN308
     @              ( L55(I),I=1,4),( L55(I), Q55(I+12),I=8,13),        PRIN309
     @              ( L50(I),I=1,4),( L50(I), Q50(I+12),I=8,13)         PRIN310
      WRITE(N6,6841)( L45(I),I=1,4),( L45(I), Q45(I+12),I=8,13),        PRIN311
     @              ( L40(I),I=1,4),( L40(I), Q40(I+12),I=8,13),        PRIN312
     @              ( L35(I),I=1,4),( L35(I), Q35(I+12),I=8,13),        PRIN313
     @              ( L30(I),I=1,4),( L30(I), Q30(I+12),I=8,13),        PRIN314
     @              ( L25(I),I=1,4),( L25(I), Q25(I+12),I=8,13),        PRIN315
     @              ( L20(I),I=1,4),( L20(I), Q20(I+12),I=8,13),        PRIN316
     @              ( L15(I),I=1,4),( L15(I), Q15(I+12),I=8,13),        PRIN317
     @              ( L10(I),I=1,4),( L10(I), Q10(I+12),I=8,13),        PRIN318
     @              (  L5(I),I=1,4),(  L5(I),  Q5(I+12),I=8,13)         PRIN319
 6002 FORMAT(//T2,4HTOT ,3F6.0,F7.0,6(5X,F5.0,F7.1),                    PRIN320
     @      //T2,4HAVG ,3F6.1,F7.1,6(5X,F5.1,F7.1),                     PRIN321
     @      //T2,4HSIG ,3F6.1,F7.1,6(5X,F5.1,F7.1),                     PRIN322
     @      //T2,4HMAX ,3F6.0,F7.0,6(5X,F5.0,F7.1),                     PRIN323
     @      //T2,4HMIN ,3F6.0,F7.0,6(5X,F5.0,F7.1))                     PRIN324
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Table A-6 (Continued)

```
683   FORMAT(//T2,4H95% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN325
     @        /T2,4H90% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN326
     @        /T2,4H85% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN327
     @        /T2,4H80% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN328
     @        /T2,4H75% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN329
     @        /T2,4H70% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN330
     @        /T2,4H65% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN331
     @        /T2,4H60% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN332
     @        /T2,4H55% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN333
     @        /T2,4H50% ,3F6.1,F7.1,6(5X,F5.1,F7.1))                   PRIN334
684   FORMAT(  T2,4H45% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN335
     @        /T2,4H40% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN336
     @        /T2,4H35% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN337
     @        /T2,4H30% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN338
     @        /T2,4H25% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN339
     @        /T2,4H20% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN340
     @        /T2,4H15% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN341
     @        /T2,4H10% ,3F6.1,F7.1,6(5X,F5.1,F7.1),                   PRIN342
     @        /T2,4H 5% ,3F6.1,F7.1,6(5X,F5.1,F7.1))                   PRIN343
6831  FORMAT(//T2,4H95% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN344
     @        /T2,4H90% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN345
     @        /T2,4H85% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN346
     @        /T2,4H80% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN347
     @        /T2,4H75% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN348
     @        /T2,4H70% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN349
     @        /T2,4H65% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN350
     @        /T2,4H60% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN351
     @        /T2,4H55% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN352
     @        /T2,4H50% ,3I6  ,I7  ,6(5X,I5  ,F7.1))                   PRIN353
6841  FORMAT(  T2,4H45% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN354
     @        /T2,4H40% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN355
     @        /T2,4H35% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN356
     @        /T2,4H30% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN357
     @        /T2,4H25% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN358
     @        /T2,4H20% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN359
     @        /T2,4H15% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN360
     @        /T2,4H10% ,3I6  ,I7  ,6(5X,I5  ,F7.1),                   PRIN361
     @        /T2,4H 5% ,3I6  ,I7  ,6(5X,I5  ,F7.1))                   PRIN362
 103  CONTINUE                                                         PRIN363
      WRITE(N6,6201)                                                   PRIN364
      IF (KQQ.EQ.1) WRITE(N6,6200)                                     PRIN365
      IF (KQQ.EQ.2) WRITE(N6,6220)                                     PRIN366
      IF (KQQ.EQ.3) WRITE(N6,6240)                                     PRIN367
      IF (KQQ.EQ.4) WRITE(N6,6260)                                     PRIN368
      IF (KQQ.EQ.5) WRITE(N6,6280)                                     PRIN369
      IF(M.EQ.1) WRITE(N6,6291)                                        PRIN370
      IF(M.EQ.2) WRITE(N6,6292) X                                      PRIN371
      IF(M.EQ.1) WRITE(N6,6951) X                                      PRIN372
      IF(M.EQ.2) WRITE(N6,695) X                                       PRIN373
 695 FORMAT(1H0,                                                       PRIN374
     @ T2,131('-')//,T14,'HOURS',T36,'7TH MONTH',T53,'8TH MONTH',T70,  PRIN375
     @'9TH MONTH',T87,'10TH MONTH',T104,'11TH MONTH',T121,'12TH MONTH'/ PRIN376
     @ T14,'OVFL   ANN   ANN',T31,6('   ---------------')/,            PRIN377
     @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',T31,                  PRIN378
     @ 6('       VIOL  % OF')/,                                        PRIN379
     @ T2,'YEAR  HRS   MGAL  EVENTS DAYS',T31,                         PRIN380
     @ 6('   MON DAYS MONTH')/,                                        PRIN381
     @ T2,'----- ---- ------ ------ ----',T31,                         PRIN382
     @ 6('   --- ---- -----')/)                                        PRIN383
6951 FORMAT(1H0,                                                       PRIN384
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Table A-6 (Continued)

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      @ T2,131('-')//,T14,'HOURS',T36,'   JAN   ',T53,'   FEB   ',T70,   PRIN385
      @'   MAR   ',T87,'   APR   ',T104,'   MAY   ',T121,'   JUN   '/ PRIN386
      @ T14,'OVFL   ANN   ANN',T31,6('   --------------')/,              PRIN387
      @ T2,'WATER OVFL > ',F4.2,T20,'OVFLOW VIOL',T31,                   PRIN388
      @ 6('        VIOL  % OF')/,                                        PRIN389
      @ T2,'YEAR  HRS   MGAL  EVENTS DAYS',T31,                          PRIN390
      @ 6('   MON DAYS MONTH')/,                                         PRIN391
      @ T2,'----- ---- ------ ------ ----',T31,                          PRIN392
      @ 6('   --- ---- -----')/)                                         PRIN393
       DO 913 I=1,NM1                                                    PRIN394
         NYPRT=NWYR(I)+NYL1+1900-1                                       PRIN395
         K1=MONW(NWYR(I),7)                                              PRIN396
         K2=MONW(NWYR(I),8)                                              PRIN397
         K3=MONW(NWYR(I),9)                                              PRIN398
         K4=MONW(NWYR(I),10)                                             PRIN399
         K5=MONW(NWYR(I),11)                                             PRIN400
         K6=MONW(NWYR(I),12)                                             PRIN401
         WRITE(N6,694) NYPRT,NRYR(I),NRXYR(I),NEVYR(I),NANNVD(I),        PRIN402
     @           AMON(K1),NWVD(NWYR(I), 7),PCTVD(NWYR(I), 7),            PRIN403
     @           AMON(K2),NWVD(NWYR(I), 8),PCTVD(NWYR(I), 8),            PRIN404
     @           AMON(K3),NWVD(NWYR(I), 9),PCTVD(NWYR(I), 9),            PRIN405
     @           AMON(K4),NWVD(NWYR(I),10),PCTVD(NWYR(I),10),            PRIN406
     @           AMON(K5),NWVD(NWYR(I),11),PCTVD(NWYR(I),11),            PRIN407
     @           AMON(K6),NWVD(NWYR(I),12),PCTVD(NWYR(I),12)             PRIN408
           IF (I.EQ.40) WRITE(N6,6201)                                   PRIN409
           IF (I.EQ.40.AND.KQQ.EQ.1) WRITE(N6,6200)                      PRIN410
           IF (I.EQ.40.AND.KQQ.EQ.2) WRITE(N6,6220)                      PRIN411
           IF (I.EQ.40.AND.KQQ.EQ.3) WRITE(N6,6240)                      PRIN412
           IF (I.EQ.40.AND.KQQ.EQ.4) WRITE(N6,6260)                      PRIN413
           IF (I.EQ.40.AND.KQQ.EQ.5) WRITE(N6,6280)                      PRIN414
           IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,6291)                         PRIN415
           IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,6292) X                       PRIN416
           IF(I.EQ.40.AND.M.EQ.1) WRITE(N6,6951) X                       PRIN417
           IF(I.EQ.40.AND.M.EQ.2) WRITE(N6,695 ) X                       PRIN418
  913      CONTINUE                                                      PRIN419
         DO 105 K=1,2                                                    PRIN420
           WRITE(N6,6201)                                                PRIN421
           IF (KQQ.EQ.1) WRITE(N6,6200)                                  PRIN422
         IF (KQQ.EQ.2) WRITE(N6,6220)                                    PRIN423
         IF (KQQ.EQ.3) WRITE(N6,6240)                                    PRIN424
         IF (KQQ.EQ.4) WRITE(N6,6260)                                    PRIN425
         IF (KQQ.EQ.5) WRITE(N6,6280)                                    PRIN426
         IF(M.EQ.1) WRITE(N6,6291)                                       PRIN427
         IF(M.EQ.2) WRITE(N6,6292) X                                     PRIN428
         IF(K.EQ.1) WRITE(N6,6293)                                       PRIN429
         IF(K.EQ.2) WRITE(N6,6294)                                       PRIN430
         IF(M.EQ.1) WRITE(N6,6951) X                                     PRIN431
         IF(M.EQ.2) WRITE(N6,695) X                                      PRIN432
         WRITE(N6,6002)(XTOT(I),I=1,4),(XTOT(I),XTOT(I+12),I=14,19),     PRIN433
     @               (XAVG(I),I=1,4),(XAVG(I),XAVG(I+12),I=14,19),       PRIN434
     @               (XSIG(I),I=1,4),(XSIG(I),XSIG(I+12),I=14,19),       PRIN435
     @               (VMAX(I),I=1,4),(VMAX(I),VMAX(I+12),I=14,19),       PRIN436
     @               (VMIN(I),I=1,4),(VMIN(I),VMIN(I+12),I=14,19)        PRIN437
         IF(K.EQ.2) GO TO 106                                            PRIN438
         WRITE(N6,683) ( P95(I),I=1,4),( P95(I), P95(I+12),I=14,19),     PRIN439
     @               ( P90(I),I=1,4),( P90(I), P90(I+12),I=14,19),       PRIN440
     @               ( P85(I),I=1,4),( P85(I), P85(I+12),I=14,19),       PRIN441
     @               ( P80(I),I=1,4),( P80(I), P80(I+12),I=14,19),       PRIN442
     @               ( P75(I),I=1,4),( P75(I), P75(I+12),I=14,19),       PRIN443
     @               ( P70(I),I=1,4),( P70(I), P70(I+12),I=14,19),       PRIN444
```

Table A-6 (Continued)

```
     @               ( P65(I).I=1,4),( P65(I), P65(I+12),I=14,19),
     @               ( P60(I),I=1,4),( P60(I), F60(I+12),I=14,19),
     @               ( P55(I),I=1,4),( P55(I), P55(I+12),I=14,19),
     @               ( P50(I),I=1,4),( P50(I), P50(I+12),I=14,19)
       WRITE(N6,684) ( P45(I),I=1,4),( P45(I), P45(I+12),I=14,19),
     @               ( P40(I),I=1,4),( P40(I), P40(I+12),I=14,19),
     @               ( P35(I),I=1,4),( P35(I), P35(I+12),I=14,19),
     @               ( P30(I),I=1,4),( P30(I), P30(I+12),I=14,19),
     @               ( P25(I),I=1,4),( P25(I), P25(I+12),I=14,19),
     @               ( P20(I),I=1,4),( P20(I), P20(I+12),I=14,19),
     @               ( P15(I),I=1,4),( P15(I), P15(I+12),I=14,19),
     @               ( P10(I),I=1,4),( P10(I), P10(I+12),I=14,19),
     @               (  P5(I),I=1,4),(  P5(I),  P5(I+12),I=14,19)
       GO TO 105
 106   WRITE(N6,6831)( L95(I),I=1,4),( L95(I), Q95(I+12),I=14,19),
     @               ( L90(I),I=1,4),( L90(I), Q90(I+12),I=14,19),
     @               ( L85(I),I=1,4),( L85(I), Q85(I+12),I=14,19),
     @               ( L80(I),I=1,4),( L80(I), Q80(I+12),I=14,19),
     @               ( L75(I),I=1,4),( L75(I), Q75(I+12),I=14,19),
     @               ( L70(I),I=1,4),( L70(I), Q70(I+12),I=14,19),
     @               ( L65(I),I=1,4),( L65(I), Q65(I+12),I=14,19),
     @               ( L60(I),I=1,4),( L60(I), Q60(I+12),I=14,19),
     @               ( L55(I),I=1,4),( L55(I), Q55(I+12),I=14,19),
     @               ( L50(I),I=1,4),( L50(I), Q50(I+12),I=14,19)
       WRITE(N6,6841)( L45(I),I=1,4),( L45(I), Q45(I+12),I=14,19),
     @               ( L40(I),I=1,4),( L40(I), Q40(I+12),I=14,19),
     @               ( L35(I),I=1,4),( L35(I), Q35(I+12),I=14,19),
     @               ( L30(I),I=1,4),( L30(I), Q30(I+12),I=14,19),
     @               ( L25(I),I=1,4),( L25(I), Q25(I+12),I=14,19),
     @               ( L20(I),I=1,4),( L20(I), Q20(I+12),I=14,19),
     @               ( L15(I),I=1,4),( L15(I), Q15(I+12),I=14,19),
     @               ( L10(I),I=1,4),( L10(I), Q10(I+12),I=14,19),
     @               (  L5(I),I=1,4),(  L5(I),  Q5(I+12),I=14,19)
 105   CONTINUE
      RETURN
      END
C=======================================================================
      SUBROUTINE STATI(L)
      COMMON/BLK12/ L95(43),L90(43),L85(43),L80(43),L75(43),
     @              L70(43),L65(43),L60(43),L55(43),L50(43),L45(43),
     @              L40(43),L35(43),L30(43),L25(43),L20(43),L15(43),
     @              L10(43),L5(43)
      INTEGER*2 L95,L90,L85,L80,L75,L70,L65,L60,L55,L50,L45,L40,L35,
     @          L30,L25,L20,L15,L10,L5
      COMMON/BLK19/ IDUM(70)
      COMMON/BLK22/ NYEARS,NM1,NM2
      L95(L)=IDUM(( 1*NYEARS)/20)
      L90(L)=IDUM(( 2*NYEARS)/20)
      L85(L)=IDUM(( 3*NYEARS)/20)
      L80(L)=IDUM(( 4*NYEARS)/20)
      L75(L)=IDUM(( 5*NYEARS)/20)
      L70(L)=IDUM(( 6*NYEARS)/20)
      L65(L)=IDUM(( 7*NYEARS)/20)
      L60(L)=IDUM(( 8*NYEARS)/20)
      L55(L)=IDUM(( 9*NYEARS)/20)
      L50(L)=IDUM((10*NYEARS)/20)
      L45(L)=IDUM((11*NYEARS)/20)
      L40(L)=IDUM((12*NYEARS)/20)
      L35(L)=IDUM((13*NYEARS)/20)
      L30(L)=IDUM((14*NYEARS)/20)
```

Table A-6 (Continued)

```
      L25(L)=IDUM((15*NYEARS)/20)                                       STAI 25
      L20(L)=IDUM((16*NYEARS)/20)                                       STAI 26
      L15(L)=IDUM((17*NYEARS)/20)                                       STAI 27
      L10(L)=IDUM((18*NYEARS)/20)                                       STAI 28
       L5(L)=IDUM((19*NYEARS)/20)                                       STAI 29
      RETURN                                                            STAI 30
      END                                                               STAI 31
C=======================================================================STAR  1
      SUBROUTINE STATR(L)                                               STAR  2
      COMMON/BLK13/ Q95(43),Q90(43),Q85(43),Q80(43),Q75(43),            STAR  3
     @              Q70(43),Q65(43),Q60(43),Q55(43),Q50(43),Q45(43),    STAR  4
     @              Q40(43),Q35(43),Q30(43),Q25(43),Q20(43),Q15(43),    STAR  5
     @              Q10(43),Q5(43)                                      STAR  6
      COMMON/BLK20/ QDUM(70)                                            STAR  7
      COMMON/BLK22/ NYEARS,NM1,NM2                                      STAR  8
      Q95(L)=QDUM(( 1*NYEARS)/20)                                       STAR  9
      Q90(L)=QDUM(( 2*NYEARS)/20)                                       STAR 10
      Q85(L)=QDUM(( 3*NYEARS)/20)                                       STAR 11
      Q80(L)=QDUM(( 4*NYEARS)/20)                                       STAR 12
      Q75(L)=QDUM(( 5*NYEARS)/20)                                       STAR 13
      Q70(L)=QDUM(( 6*NYEARS)/20)                                       STAR 14
      Q65(L)=QDUM(( 7*NYEARS)/20)                                       STAR 15
      Q60(L)=QDUM(( 8*NYEARS)/20)                                       STAR 16
      Q55(L)=QDUM(( 9*NYEARS)/20)                                       STAR 17
      Q50(L)=QDUM((10*NYEARS)/20)                                       STAR 18
      Q45(L)=QDUM((11*NYEARS)/20)                                       STAR 19
      Q40(L)=QDUM((12*NYEARS)/20)                                       STAR 20
      Q35(L)=QDUM((13*NYEARS)/20)                                       STAR 21
      Q30(L)=QDUM((14*NYEARS)/20)                                       STAR 22
      Q25(L)=QDUM((15*NYEARS)/20)                                       STAR 23
      Q20(L)=QDUM((16*NYEARS)/20)                                       STAR 24
      Q15(L)=QDUM((17*NYEARS)/20)                                       STAR 25
      Q10(L)=QDUM((18*NYEARS)/20)                                       STAR 26
       Q5(L)=QDUM((19*NYEARS)/20)                                       STAR 27
      RETURN                                                            STAR 28
      END                                                               STAR 29
C=======================================================================CALC  1
      SUBROUTINE CALC                                                   CALC  2
      COMMON/BLK7/  NWDX(70,12),NWRX(70,12),NWVD(70,12)                 CALC  3
      INTEGER*2 NWDX,NWRX,NWVD                                          CALC  4
      COMMON/BLK9/  PCTRX(70,12),FCTVD(70,12)                           CALC  5
      COMMON/BLK11/ NRYR(70),NWYR(70),NEVYR(70),NRXYR(70),NANNVD(70),   CALC  6
     @              NWDXYR(70)                                          CALC  7
      INTEGER*2 NRYR,NWYR,NEVYR,NRXYR,NANNVD,NWDXYR                     CALC  8
      COMMON/BLK18/ XTEMP(70),ITEMP(70)                                 CALC  9
      COMMON/BLK19/ IDUM(70)                                            CALC 10
      COMMON/BLK20/ QDUM(70)                                            CALC 11
      COMMON/BLK21/ DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP             CALC 12
      INTEGER   DSTART,MOSTAR,ISTART,DSTOP,MOSTOP,ISTOP                 CALC 13
      COMMON/BLK22/ NYEARS,NM1,NM2                                      CALC 14
      DO 4011 I=1,NM1                                                   CALC 15
        ITEMP(I)=NRYR(I)                                                CALC 16
4011    CONTINUE                                                        CALC 17
      DO 401 I=1,NM2                                                    CALC 18
        IP1=I+1                                                         CALC 19
        DO 401 K=IP1,NM1                                                CALC 20
          IF(ITEMP(I).GE.ITEMP(K)) GO TO 402                            CALC 21
          LTEMP=ITEMP(I)                                                CALC 22
          ITEMP(I)=ITEMP(K)                                             CALC 23
          ITEMP(K)=LTEMP                                                CALC 24
```

Table A-6 (Continued)

```
402       IDUM(I)=ITEMP(I)
          IDUM(K)=ITEMP(K)
401     CONTINUE
      CALL STATI(1)
1     CONTINUE
      DO 4031 I=1,NM1
        ITEMP(I)=NRXYR(I)
4031    CONTINUE
      DO 403 I=1,NM2
        IP1=I+1
        DO 403 K=IP1,NM1
          IF(ITEMP(I).GE.ITEMP(K)) GO TO 404
          LTEMP=ITEMP(I)
          ITEMP(I)=ITEMP(K)
          ITEMP(K)=LTEMP
404       IDUM(I)=ITEMP(I)
          IDUM(K)=ITEMP(K)
403     CONTINUE
      CALL STATI(2)
2     CONTINUE
      DO 4051 I=1,NM1
        ITEMP(I)=NEVYR(I)
4051    CONTINUE
      DO 405 I=1,NM2
        IP1=I+1
        DO 405 K=IP1,NM1
          IF(ITEMP(I).GE.ITEMP(K)) GO TO 406
          LTEMP=ITEMP(I)
          ITEMP(I)=ITEMP(K)
          ITEMP(K)=LTEMP
406       IDUM(I)=ITEMP(I)
          IDUM(K)=ITEMP(K)
405     CONTINUE
      CALL STATI(3)
3     CONTINUE
      DO 4071 I=1,NM1
        ITEMP(I)=NANNVD(I)
4071    CONTINUE
      DO 407 I=1,NM2
        IP1=I+1
        DO 407 K=IP1,NM1
          IF(ITEMP(I).GE.ITEMP(K)) GO TO 408
          LTEMP=ITEMP(I)
          ITEMP(I)=ITEMP(K)
          ITEMP(K)=LTEMP
408       IDUM(I)=ITEMP(I)
          IDUM(K)=ITEMP(K)
407     CONTINUE
      CALL STATI(4)
4     CONTINUE
      DO 4091 I=1,NM1
        ITEMP(I)=NWRX(I,1)
4091    CONTINUE
      DO 409 I=1,NM2
        IP1=I+1
        DO 409 K=IP1,NM1
          IF(ITEMP(I).GE.ITEMP(K)) GO TO 410
          LTEMP=ITEMP(I)
          ITEMP(I)=ITEMP(K)
          ITEMP(K)=LTEMP
```

Table A-6 (Continued)

```
410         IDUM(I)=ITEMP(I)
            IDUM(K)=ITEMP(K)
409       CONTINUE
        CALL STATI(5)
5       CONTINUE
        DO 4111 I=1,NM1
          XTEMP(I)=PCTRX(I,1)
4111      CONTINUE
        DO 411 I=1,NM2
          IP1=I+1
          DO 411 K=IP1,NM1
            IF(XTEMP(I).GE.XTEMP(K)) GO TO 412
            ZTEMP=XTEMP(I)
            XTEMP(I)=XTEMP(K)
            XTEMP(K)=ZTEMP
412         QDUM(I)=XTEMP(I)
            QDUM(K)=XTEMP(K)
411       CONTINUE
        CALL STATR(6)
6       CONTINUE
        DO 4131 I=1,NM1
          ITEMP(I)=NWDXYR(I)
4131      CONTINUE
        DO 413 I=1,NM2
          IP1=I+1
          DO 413 K=IP1,NM1
            IF(ITEMP(I).GE.ITEMP(K)) GO TO 414
            LTEMP=ITEMP(I)
            ITEMP(I)=ITEMP(K)
            ITEMP(K)=LTEMP
414         IDUM(I)=ITEMP(I)
            IDUM(K)=ITEMP(K)
413       CONTINUE
        CALL STATI(7)
7       CONTINUE
        DO 511 KK=1,12
          DO 5111 J=1,NM1
            ITEMP(J)=NNVD(NWYR(J),KK)
5111        CONTINUE
          DO 512 I=1,NM2
            IP1=I+1
            DO 512 K=IP1,NM1
              IF(ITEMP(I).GE.ITEMP(K)) GO TO 513
              LTEMP=ITEMP(I)
              ITEMP(I)=ITEMP(K)
              ITEMP(K)=LTEMP
513           IDUM(I)=ITEMP(I)
              IDUM(K)=ITEMP(K)
512         CONTINUE
          CALL STATI(KK+7)
511       CONTINUE
        DO 521 KK=1,12
          DO 5211 J=1,NM1
            XTEMP(J)=PCTVD(NWYR(J),KK)
5211        CONTINUE
          DO 522 I=1,NM2
            IP1=I+1
            DO 522 K=IP1,NM1
              IF(XTEMP(I) .GE.XTEMP(K) ) GO TO 523
              ZTEMP=XTEMP(I)
```

Table A-6 (Concluded)

```
              XTEMP(I) =XTEMP(K)
              XTEMP(K) =ZTEMP
523           QDUM(I)=XTEMP(I)
              QDUM(K)=XTEMP(K)
522         CONTINUE
          CALL STATR(KK+19)
521       CONTINUE
        DO 501 KK=1,12
          DO 5011 J=1,NM1
            ITEMP(J)=NWDX(J,KK)
5011        CONTINUE
          DO 502 I=1,NM2
            IP1=I+1
            DO 502 K=IP1,NM1
              IF(ITEMP(I).GE.ITEMP(K)) GO TO 503
              LTEMP=ITEMP(I)
              ITEMP(I)=ITEMP(K)
              ITEMP(K)=LTEMP
503           IDUM(I)=ITEMP(I)
              IDUM(K)=ITEMP(K)
502         CONTINUE
          CALL STATI(KK+31)
501       CONTINUE
        RETURN
        END
C ==================================================================
        BLOCK DATA
        COMMON/BLK15/ MON(12),CREC(5),CSHEL(30),CSTAT(19)
        COMMON/BLK16/ BMON(12)
        COMMON/BLK17/ AMON(12)
        DATA AMON/3HJUL,3HAUG,3HSEP,3HOCT,3HNOV,3HDEC,3HJAN,3HFEB,
       @          3HMAR,3HAPR,3HMAY,3HJUN/
        DATA BMON/3HJAN,3HFEB,3HMAR,3HAPR,3HMAY,3HJUN,3HJUL,3HAUG,
       @          3HSEP,3HOCT,3HNOV,3HDEC/
        DATA MON/31,28,31,30,31,30,31,31,30,31,30,31/
        DATA CREC/5*0./,CSHEL/30*0./
        DATA CSTAT/1.645,1.2817,1.0365,0.8418,0.6745,0.5244,0.3854,
       @           0.2533,0.1256,0.0,-0.1256,-0.2533,-0.3854,-0.5244,
       @           -0.6745,-0.8418,-1.0365,-1.2817,-1.645/
        END
```

Table A-7. VDAY PROGRAM VARIABLES LIST

Variable name	Index*	Description	Unit
A		Total hours in month	h
ABC		Temporary variable	--
ABD		Temporary variable	--
ALOG		External function name	--
ALPHA	I,O	Coliform concentration concentration factor	--
AMON	C,O	Abbreviation of name of month (water year)	--
B		Temporary variable	--
BETA	I,O	Coliform concentration exponentiation factor	--
BMOM	C,O	Abbreviation of name of month (calendar year)	--
BMULT	I,O	Coliform concentration multiplier	--
BNEW		Exponentiation decay factor	h^{-1}
BNEWR	I,O	Coliform attenuation coefficient	--
C		Number of hours in the violation days during a month	h
CALC		Subroutine name	--
CB	I,O	Overflow coliform concentration	MPN/100 mL
CO		Number of coliform organisms in overflow	MPN
COLI	C	Coliform concentration in receiving water	MPN/100 mL
CPAR		Decay factor as exponential fraction	--
CPARLM		Decay exponent	--
CR		Coliform concenration in receiving water	MPN/100 mL
CREC	C	Coliform concentration for day (recreation)	MPN/100 mL
CS		Receiving water background coliform concentration	MPN/100 mL
CSHEL		Coliform concentration for day (shellfish)	MPN/100 mL
CTOT		Coliform concentration tracked	MPN/100 mL
DSTART	I,C,O	Day of month simulation starts	--
DSTOP	I,C,O	Day of month simulation ends	--
EFLOW	C	Flow volume during storm event	Mgal
EVENT1		Event counter	--
EVENT2		Event counter	--
EXP		External function name	--
FLOAT		External function name	--
I		Do loop counter	--
IDUM	C	Temporary variable	--
IFIX		External function name	--
IP1		Do loop counter	--
IRC10M		Flag for violation day	--
IRC240		Flag for violation day	--
ISHL70		Flag for violation day	--
ISH10M		Flag for violation day	--
ISH230		Flag for violation day	--
ISTART	I,C,O	Year simulation starts	--
ISTOP	I,C,O	Year simulation stops	--
ITEMP	C	Bookkeeping integer	--

Table A-7 (Continued)

Variable name	Index*	Description	Unit
J		Do loop counter	--
JCC		Hours without rain counter	--
JX		Number of storms counter	--
JXX	O	Storm in progress index	--
K		Do loop counter	--
KFLAG		Flag for reading dates	--
KK		Do loop counter	--
KPAGE	C	Bookkeeping integer	--
KQQ		Do loop counter	--
KSEQ	I,O	Flag for printing sequenced water year summary table	--
KSUM	I,O	Flag for printing summary table	--
KWAT	I,O	Flag for printing water year summary table	--
KWGS	I,O	Identifier for last input data set	--
K1		Bookkeeping integer	--
K2		Bookkeeping integer	--
K3		Bookkeeping integer	--
K4		Bookkeeping integer	--
K5		Bookkeeping integer	--
K6		Bookkeeping integer	--
L		Factor used to find leap year	--
LASTMO		Factor used to determine end of month	--
LTEMP		Temporary variable for ranking values	--
L5	C,O	5th percentile value	--
L10	C,O	10th percentile value	--
L15	C,O	15th percentile value	--
L20	C,O	20th percentile value	--
L25	C,O	25th percentile value	--
L30	C,O	30th percentile value	--
L35	C,O	35th percentile value	--
L40	C,O	40th percentile value	--
L45	C,O	45th percentile value	--
L50	C,O	50th percentile value	--
L55	C,O	55th percentile value	--
L60	C,O	60th percentile value	--
L65	C,O	65th percentile value	--
L70	C,O	70th percentile value	--
L75	C,O	75th percentile value	--
L80	C,O	80th percentile value	--
L85	C,O	85th percentile value	--
L90	C,O	90th percentile value	--
L95	C,O	95th percentile value	--

Table A-7 (Continued)

Variable name	Index*	Description	Units
M		Do loop counter	--
MO	O	Month number of rainfall	--
MON	C	Number of days in month	--
MONTH	C,O	Month number in check for leap year	--
MONW	C,O	Month number for water year	--
MOSTAR	I,C,O	Month number for start of simulation period	--
MOSTOP	I,C,O	Month number for end of simulation perios	--
NANNVD	C,O	Number of annual violation days	--
NCALYR	C,O	Number of calendar year	--
ND	O	Day number of rainfall	--
NDAYS	C,O	Number of days in month (calendar year)	d
NDX	C,O	Number of violation days in month	--
NDXM		Counter for violation days in month	--
NEV	C,O	Number of storm events in month	--
NEVYR	C,O	Number of storm events in year	--
NEWVOL		Volume of overflow	acre-in
NIN	I,O	Disk input file logical unit number	--
NMED		Counter for determining median	--
NM1	C	Counter for determining length of simulation period	yr
NM2	C	Counter for determining length of simulation period	yr
NRH	C,O	Number of hours of rain	h
NRHM		Hours of rain during month	h
NRX	C,O	Hours with overflow greater than X	h
NRXL		Hours in last month with overflow greater than X	h
NRXM		Hours in month with overflow greater than X	h
NRXYR	C,O	Hours in year with overflow greater than X	h
NRYR	C,O	Hours of overflow in year	h
NTEMP		Temporary variable	--
NTEN		Counter for determining 10 percentile coliform limit violations	--
NTIME		Number of years in simulation period	yr
NTWENT		Counter for determining 20 percentile coliform limit violations	
NVD	C,O	Number of violation days in month	d
NVDA	C	Indicator for violation day	--
NWATYR	C,O	Number of water year	--
NWDAYS	C,O	Number of days in month (water year)	d
NWDX	C,O	Days in month overflow is greater than X	d
NWDXYR	C,O	Days in water year overflow is greater than X	d
NWEV	C,O	Overflow events in water year	--
NWRH	C,O	Hours in month with overflow	h
NWRX	C,O	Hours in month with overflow greater than X	h
NWVD	C,O	Violation days in month (water year)	d
NWYR	C	Water year counter	--
NXZ		Bookkeeping integer	--
NY	O	Year number of rainfall	--

Table A-7 (Continued)

Variable name	Index*	Description	Unit
NYEARS	C	Number of years to be simulated	--
NYL	I,O	Previous year number	--
NYL1		Previous year number	--
NYL1M1		Previous year number minus 1	--
NYPRT	O	Water year number	--
N5	C	Card reader logical unit number	--
N6	C	Printer logical number	--
OFLOW	C	Overflow volume during hour	Mgal/h
OLDVOL		Overflow volume	Mgal
OVOL		Total volume of overflow	Mgal
PCTCRX	C,O	Percent of time in month overflow is greater than X	--
PCTCVD	C,O	Percent of month as violation days	--
PCTRX	C,O	Percent of hours in month overflow is greater than X	--
PCTVD	C,O	Percent of month as violation days	--
PRINT		Subroutine name	--
P5	C,O	5th percentile value	--
P10	C,O	10th percentile value	--
P15	C,O	15th percentile value	--
P20	C,O	20th percentile value	--
P25	C,O	25th percentile value	--
P30	C,O	30th percentile value	--
P35	C,O	35th percentile value	--
P40	C,O	40th percentile value	--
P45	C,O	45th percentile value	--
P50	C,O	50th percentile value	--
P55	C,O	55th percentile value	--
P60	C,O	60th percentile value	--
P65	C,O	65th percentile value	--
P70	C,O	70th percentile value	--
P75	C,O	75th percentile value	--
P80	C,O	80th percentile value	--
P85	C,O	85th percentile value	--
P90	C,O	90th percentile value	--
P95	C,O	95th percentile value	--
QDUM	C	Temporary variable (real)	--
Q5	C,O	5th percentile value	--
Q10	C,O	10th percentile value	--
Q15	C,O	15th percentile value	--
Q20	C,O	20th percentile value	--
Q25	C,O	25th percentile value	--
Q30	C,O	30th percentile value	--

Table A-7 (Concluded)

Variable name	Index*	Description	Unit
Q40	C,O	35th percentile value	--
Q45	C,O	40th percentile value	--
Q50	C,O	45th percentile value	--
Q55	C,O	50th percentile value	--
Q60	C,O	55th percentile value	--
Q65	C,O	60th percentile value	--
Q70	C,O	65th percentile value	--
Q75	C,O	70th percentile value	--
Q80	C,O	75th percentile value	--
Q85	C,O	80th percentile value	--
Q90	C,O	85th percentile value	--
Q95	C,O	90th percentile value	--
Q95	C,O	95th percentile value	--
RFLOW	C	Overflow volume during hour	Mgal/h
SQRT		Mathematical function (square root)	--
STATI		Subroutine name	--
STATR		Subroutine name	--
SUMM		Subroutine name	--
T		Overflow event clock running time	h
TEMP		Temporary variable	--
TIMEM		Difference between number of ending and starting month for simulation	mo
TIMER		Remaining fraction of year	yr
TIMEX		Number of years of simulation (floating point)	yr
TIMEY		Difference between number of ending and starting year for simulation	yr
TITLE	I,C,O	Descriptive title for output identification	--
VMAX	O	Maximum value for variable	--
VMIN	O	Minimum value for variable	--
WATSEQ		Subroutine name	--
WATSUM		Subroutine name	--
X	I,C,O	Overflow volume limit value	Mgal
XAVG	O	Average value	--
XL		Temporary value (leap year identifier)	--
XSIG	O	Standard deviation	--
XSQ	C	Square of variable	--
XTEMP	C	Temporary variable	--
XTOT	O	Sum of variable	--
XXL		Temporary value (leap year identifier)	--
Y	I,O	Number of hours without overflow to separate overflow events	h
ZTEMP		Temporary variable	--

* NOTE: I = Input variable
C = Common variable
O = Output variable

Appendix B

VERIFICATION OF THE SAN FRANCISCO MAC MODEL, SFMAC [1]

The San Francisco MACroscopic Planning Model, SFMAC, is a computer program that simulates continuous time histories of runoff and computes the frequency and volume of overflows [1]. The comparison of SFMAC results with TREAT IV (the city's model) and with historical storm-event data was used to verify SFMAC. The verification of SFMAC is discussed in this appendix.

SFMAC VERIFICATION

Input data consisting of tributary area, rainfall, and runoff coefficients were used during verification of the model. The tributary areas were developed from established watersheds documented in the San Francisco Interim Criteria Report. Rainfall data were synthesized for each of the 23 subareas shown in Figure B-1 from records for the City's 30 raingage network.

The runoff coefficients used as SFMAC input data were developed from a previous analysis done by the city. The runoff coefficients used, compared with weighted average coefficients computed using San Francisco land use data and typical urban gross runoff coefficient values, are shown in Table B-1. The runoff coefficients used as SFMAC input data closely agree with the computed values, the average difference being 0.05.

The verification of SFMAC calibration involved comparing results from the model with the city's TREAT IV computer model output and with actual stormflow data. Results for the North Shore watershed are presented as an example in both verification studies. In practice, all three of the city's major watersheds were used in the actual stormflow comparison study.

Using the 70-year Federal Office Building (FOB) rainfall record, SFMAC and TREAT IV were used to model the North Shore watershed. A summary of the input data and output results is presented in Table B-2. The comparisons were made using existing computer runs available at the beginning of the project.

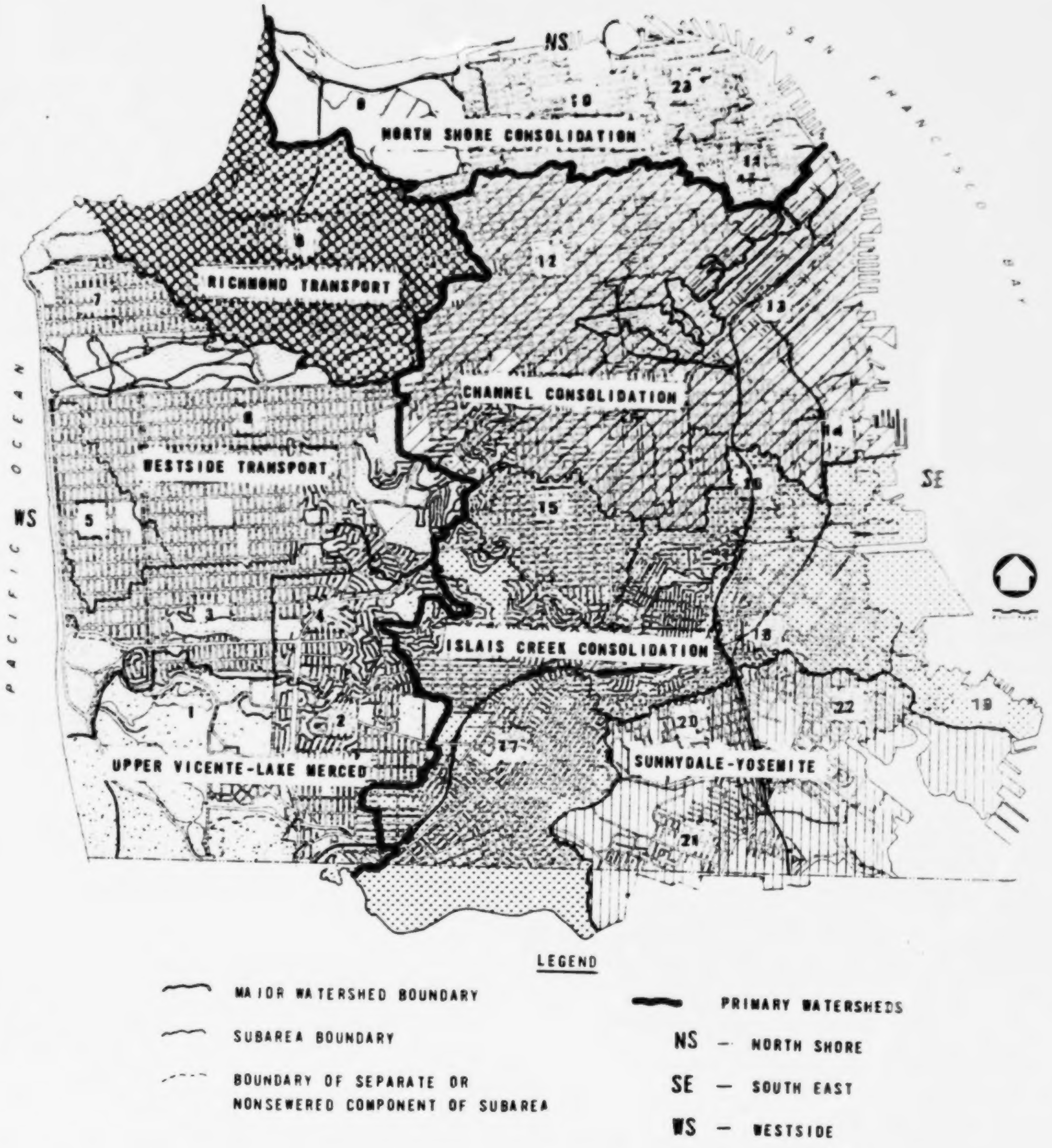


Figure B-1. Subareas and major watersheds.

Table B-1. COMPARISON OF RUNOFF COEFFICIENTS

Subarea[a]	SFMAC value from city data	Computed value based on land use[b]
1	0.60	0.51
2	0.60	0.65
3	0.63	0.60
4	0.63	0.61
5	0.61	0.59
6	0.50	0.54
7	0.52	0.54
8	0.51	0.54
9	0.60	0.66
10	0.70	0.73
11	0.75	0.76
12	0.69	0.73
13	0.73	0.76
14	0.64	0.73
15	0.60	0.56
16	0.60	0.64
17	0.60	0.57
18	0.60	0.59
19	0.60	0.37
20	0.55	0.48
21	0.60	0.50
22	0.66	0.50
23	0.75	0.77

a. See Figure B-1 for subarea location.

b. Assumed gross runoff coefficient by land use:

Land use	North Point	Richmond-Sunset Southeast
Residential	0.80	0.70
Commercial	0.95	0.90
Industrial	0.95	0.90
Open	0.20	0.20

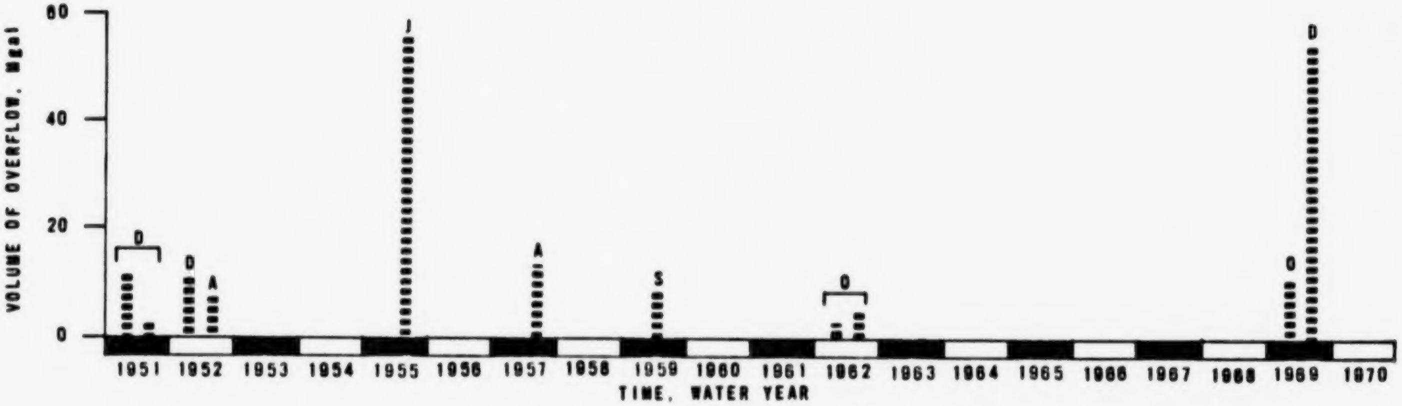
Table B-2. SUMMARY OF SFMAC COMPARISON WITH TREAT IV

	Treat IV		SFMAC	
	Condition 1	Condition 2	Condition 1	Condition 2
Input variables				
Total area, acres	2,239		2,189	
Number of subareas	1		4	
Weighted average runoff coefficient	0.71		0.71	
Rainfall factor	1.12		1.12	
Treatment rate, Mgal/d				
Wet weather	157		100	
Dry weather	--		30	
Total	157		130	
Storage capacity, Mgal	31.2	27.0	31.2	23.2
Output summary (70 years of record)				
Number of overflow events	36	64	65	117
Number of hours with overflow	82	132	143	291
Volume of overflow, Mgal	443	646	690	1,370

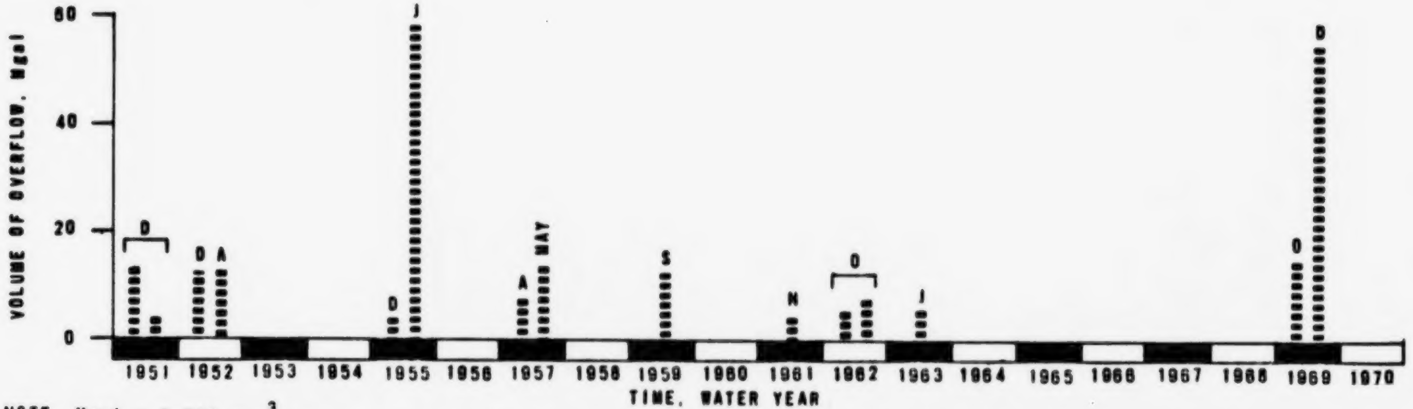
Mgal x 3,785 = m^3
Mgal/d x 0.0438 = m^3/s

The major difference in the input data is the wet-weather treatment rate; this difference is reflected in output from the two models. While the SFMAC wet-weather treatment rate is 64% of the TREAT IV rate, the SFMAC total treatment rate is 83% of that for TREAT IV. The SFMAC output for number of overflows, hours with overflow, and overflow volume ranges from 1.6 to 2.2 times that of TREAT IV output values. For the additional 29 overflows calculated by SFMAC, as a result of the 27 Mgal/d (1.2 m^3/s) lower treatment rate capacity used in the SFMAC analysis, the average duration of the additional overflows was 2.1 hours and the average additional volume overflowed was 8.5 Mgal (32 ML).

Another comparison, the overflow volume for each overflow event during a 20-year simulation period as computed by the two models, is shown in Figure B-2. Due to total treatment rate differences, SFMAC predicted four more overflows and slightly larger overflow volumes than TREAT IV. When the minor differences in the number of overflow events and overflow volumes between the two models were compared over the 20 year simulation period, the verification was considered satisfactory.



TREAT IV, 31.2 Mgal STORAGE, 157 Mgal/d PUMPING



NOTE. Mgal x 3.785 = m^3
Mgal/d x 0.438 = m^3/s

SFMAC, 31.2 Mgal STORAGE, 130 Mgal/d PUMPING

Figure B-2. Comparison of 20 year simulation of overflow volumes, North Shore watershed.

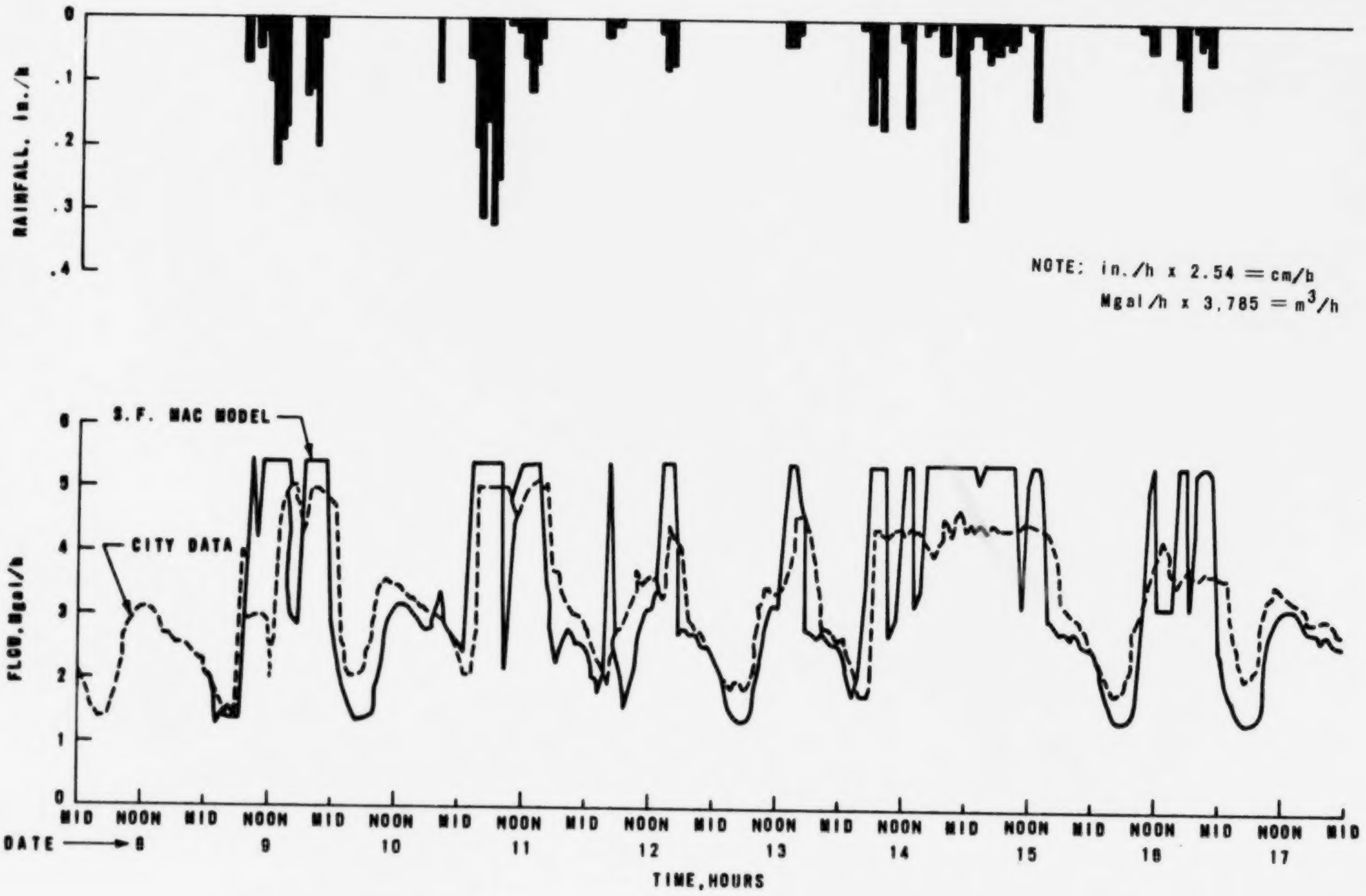
Also, both models illustrate the expected effect of an increased storage volume providing greater control of overflow frequency and volume. This increased control for both models resulted in reduction of the number of overflow events, the number of hours with overflow, and the volume of overflow.

Actual stormflow data for six storms during the spring and fall of 1977 were compiled for all three watersheds. The stormflow data included treatment plant influent flow and quality, along with overflow events and durations. Plots comparing influent plant flow, influent BOD and SS concentrations, and overflow frequency and duration with the SFMAC calculated values were drawn for all six storms. A plot of the recorded and SFMAC predicted North Point Water Pollution Control Plant influent flow for one of the storms is presented in Figure B-3. The recorded rainfall is shown at the top of Figure B-3. Heavy rainfall is quickly followed by peaks in both SFMAC calculated and North Point recorded flows. Both plots display closely similar transition periods. The North Point WPCP plot has lower, less sustained peaks than SFMAC due to the control the operators have at the plant. The response patterns for both the actual and the predicted plant flows to the recorded rainfall are the same.

A comparison of recorded overflow frequency and duration as compared with SFMAC predictions for the same storm is shown in Figure B-4. Again, although the two plots are not identical, the patterns are alike.

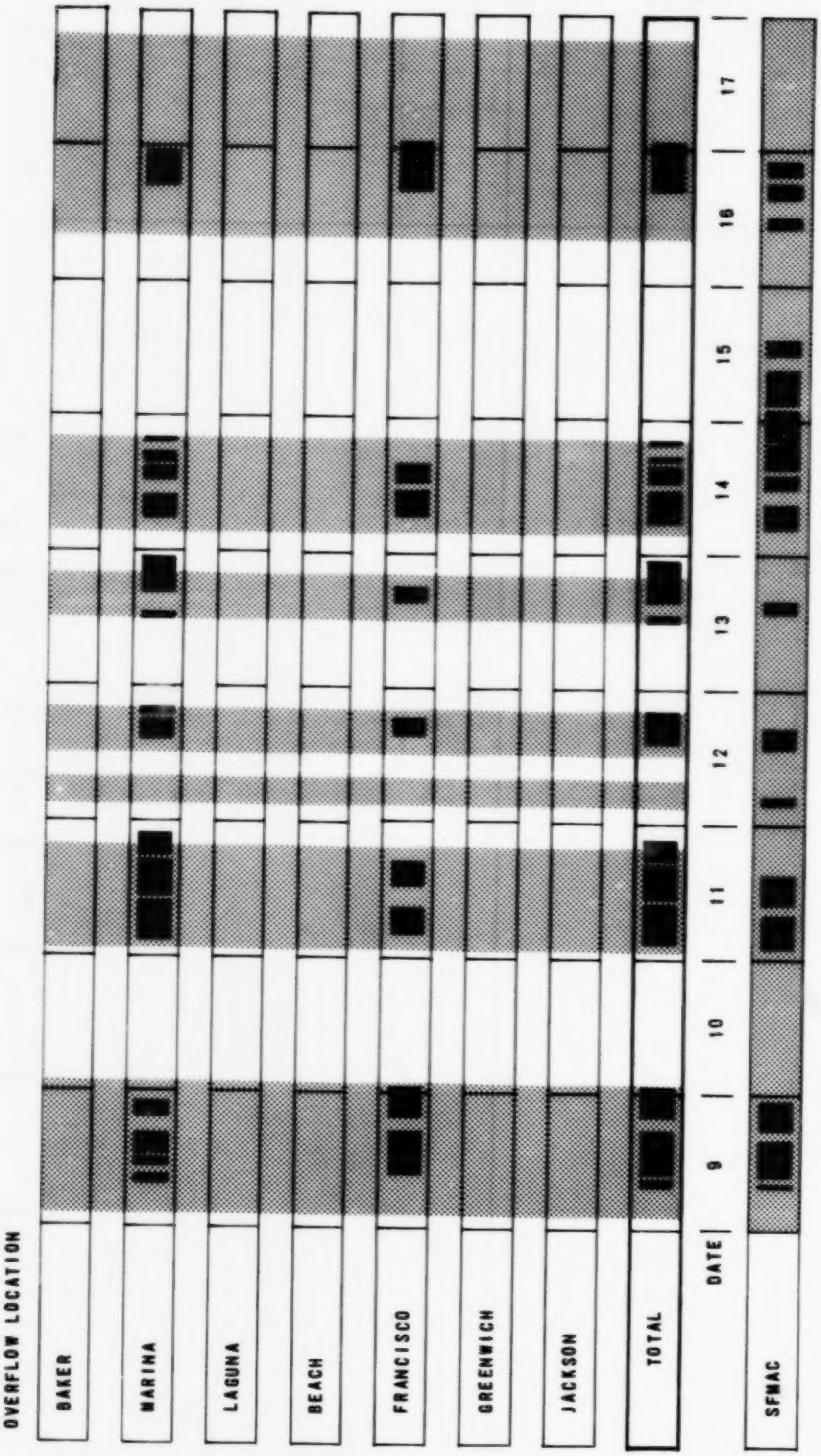
Correlation coefficients for flow, BOD, and SS graphs for the six storms for all three watersheds were calculated. A summary of the coefficients is shown in Table B-3. The values range from 0.6 to 0.9 for flow, 0.4 to 0.7 for BOD concentration, and 0.3 to 0.5 for SS concentration. These statistics are not overly impressive in themselves. However, consideration must be given to the fact that only six storms--varying widely in duration, intensity, and rainfall pattern--were examined. Total storm rainfall ranged from 0.06 to 1.50 in. (1.5 to 3.8 cm) with storm durations of 3 to 29 hours. The nonuniformity and scarcity of the storm event data limit the effectiveness of the statistical correlation.

SFMAC is a simple model but has broad analytical coverage. The results are comparable with those of TREAT IV, differences being mostly the result of minor input data variation. SFMAC has enough precision to predict plant flow and overflow frequency patterns that agree reasonably well with recorded storm data.



NOTE: in./h x 2.54 = cm/h
Mgal/h x 3.785 = m^3/h

Figure B-3. Comparison of recorded North Point plant flow with SFMAC predicted values (October 8-17, 1977).



NOTE: SOLID AREAS INDICATE DURATION OF OVERFLOW. SHADED AREAS INDICATE PERIODS FOR WHICH SEWER FLOW DEPTH RECORDS WERE AVAILABLE.

Figure B-4. Comparison of recorded overflow with SFMAC values (October 9-17, 1977).

Table B-3. SUMMARY OF CORRELATION COEFFICIENTS[a]

		Flow		BOD		SS	
Watershed	Date of 1977 storm	No. of data points	Final run[b]	No. of data points	Final run	No. of data points	Final run
Richmond-Sunset	3/23-24	37	0.84	19	0.61	27	0.12
	5/8	12	0.74	7	0.98	7	0.06
	5/26	9	0.98	5	0.88	5	0.66
	9/19-19	17	0.83	11	0.55	11	0.64
	10/28	12	0.98	11	0.50	11	0.76
	11/20-22	38	0.89	33	0.43	36	0.51
Avg			0.88		0.66		0.46
North Point	2/23-24	43	0.84	10	0.63	10	-0.33
	5/8	12	0.83	5	0.71	5	0.59
	5/26	9	0.96	7	0.77	7	0.74
	9/18-19	16	0.50	9	0.69	9	0.53
	10/28	17	0.73	14	-0.16	14	0.32
	11/20-22	39	0.73	36	0.32	36	0.49
Avg			0.77		0.55		0.50
Southeast	3/23-24	48	0.76	22	0.33	22	0.19
	5/8	17	0.76	6	-0.67	6	-0.89
	5/26	7	0.81	8	0.29	10	0.16
	9/18-19	24	0.54	20	0.76	20	0.02
	10/28	17	0.31	16	0.51	16	-0.17
	11/20-22	35	0.49	32	0.14	32	0.22
Avg			0.61		0.45		0.28
Overall avg			0.75		0.55		0.41

Note: Southeast data are with 5.0 Mgal (18,900 m^3) storage. North Point SFMAC run includes +1 hour shift and +25% increase in values.

a. The correlation coefficient is the measure of the joint behavior of two variables having a bivariate normal distribution. The correlation coefficient lies between -1 and +1. A perfect correlation equals an absolute value of 1.0; no correlation equals 0.0. Negative values of the correlation coefficient indicate a negative slope.

b. December 28, 1977.

Appendix C

SELECTION OF EPAMAC STORAGE SEDIMENTATION VARIABLES

INTRODUCTION

The purpose of this appendix is to present methodologies for the user to select EPAMAC variables REMSTS (percent removal of suspended solids in storage) and REMSTB (percent removal of BOD in storage). As described in Section 11, these variables are used to account for improving overflow quality by sedimentation in storage/transport facilities. The variables are percent removals which are applied to the overflow volume. Overflow pollutant loads are reduced by the specified removals and the removed pollutant load is returned to the storage volume.

The user should note the percent removal only applies during an overflow event when the storage facility is full. The percent removal under such conditions will be much different than for annual overall efficiency or overall storm efficiency for a facility. A study of a San Francisco storage/transport facility indicated removals during overflow conditions may be as low as 15 to 20% rather than the overall efficiencies reported for the other facilities of 60 to 70% and higher.

This feature of modeling the improvement in the quality of the overflow by sedimentation is a new feature to EPAMAC. The extensive modeling conducted in San Francisco used the SFMAC version, which did not contain this feature. As a result, there is no extensive data base to refer to when selecting values for REMSTS and REMSTB, or evaluating their reliability.

Some fundamental ideas of sedimentation theory are discussed next. Following the theory, three methods of selecting the variables will be presented. The user should examine the three options and select the most appropriate method for the system being analyzed. Detailed theoretical backup for the methods is not provided. Users are encouraged to examine the references for detailed theoretical background.

SEDIMENTATION THEORY BASICS

Sedimentation, in simple terms, is the process of suspended particles settling out of a fluid. In a motionless fluid, a particle will move vertically due to gravity (if the particle density differs from the fluid). The particle velocity under these conditions is called the quiescent setting velocity (ν). Factors influencing the velocity are particle size, shape, and the tendency to form a floc with other particles. Settling columns are used to determine the quiescent settling velocities.

Dalrymple et al. described the procedure, and conducted analyses on sanitary and stormwater samples to determine settling velocities [1]. The curves derived from these tests are shown in Figure C-1. Also indicated in Figure C-1 are settling velocity curves from similar analyses of San Francisco stormwater samples.

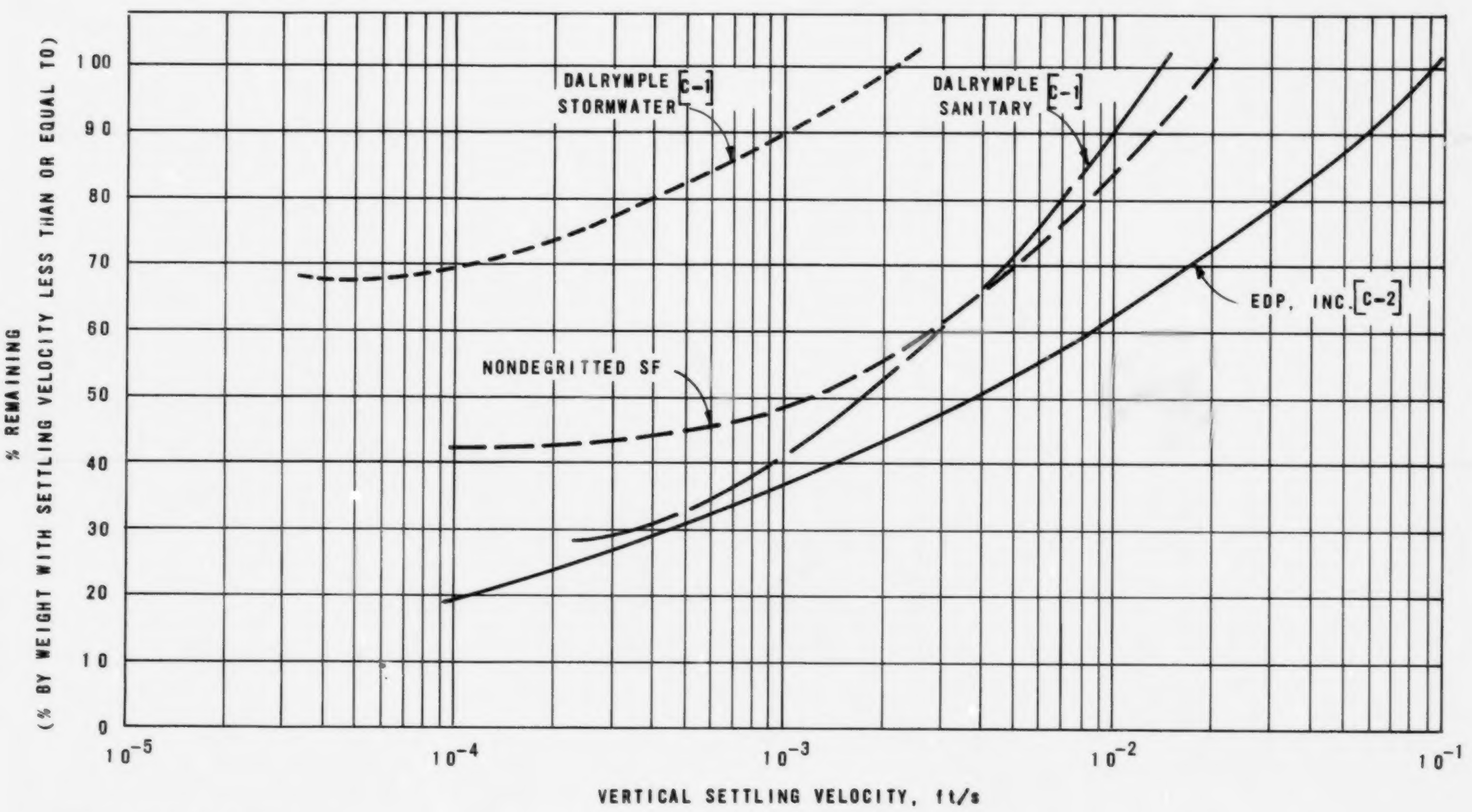
Since the fluid is not at rest in sedimentation/transport facilities, additional factors influence the behavior of particles. The physical characteristics of the facility will determine horizontal velocities (V) and mixing relationships. For a given length (L), if the time required to traverse L for a given V is short, only those particles with a high settling velocity will have time to settle out. If a transport system consists mainly of pipes and tunnels, it is possible that velocities would remain sufficiently high to prevent significant deposition of sediment.

Turbulence is another factor influencing settling velocities. The particles are subject to motion similar to diffusion which maintains the particles in suspension longer. Dobbins and Camp both investigated turbulence and derived, for a simplified case, a relationship to determine the reduction factor (r) [3, 4]. An expansion of a figure developed by Camp is shown in Figure C-2. The reduction factor indicates the fraction of material that will settle out.

A last fundamental factor influencing sedimentation is scour. Scour is the condition where previously settled particles reenter the flow stream. High horizontal velocities cause scour. The user should determine if storage facilities operate under scour conditions at times of overflow. If so, then REMSTB and REMSTS should be zero since no net settling effect will occur.

VARIABLE SELECTION METHODS

Three methods of selecting EPAMAC variables REMSTS and REMSTB are presented. The first, the sensitivity method, is best suited to planning analyses where few facilities exist and no sediment settling velocity data are available. The second, the relative comparison method, requires settling velocity data and physical system information. The third, the detailed method, requires rigorous application of settling velocity data, sieve analyses, and system physical information. Each method is described.



NOTE ft/s X 0.305 = m/s

Figure C-1. Typical settling velocity curves.

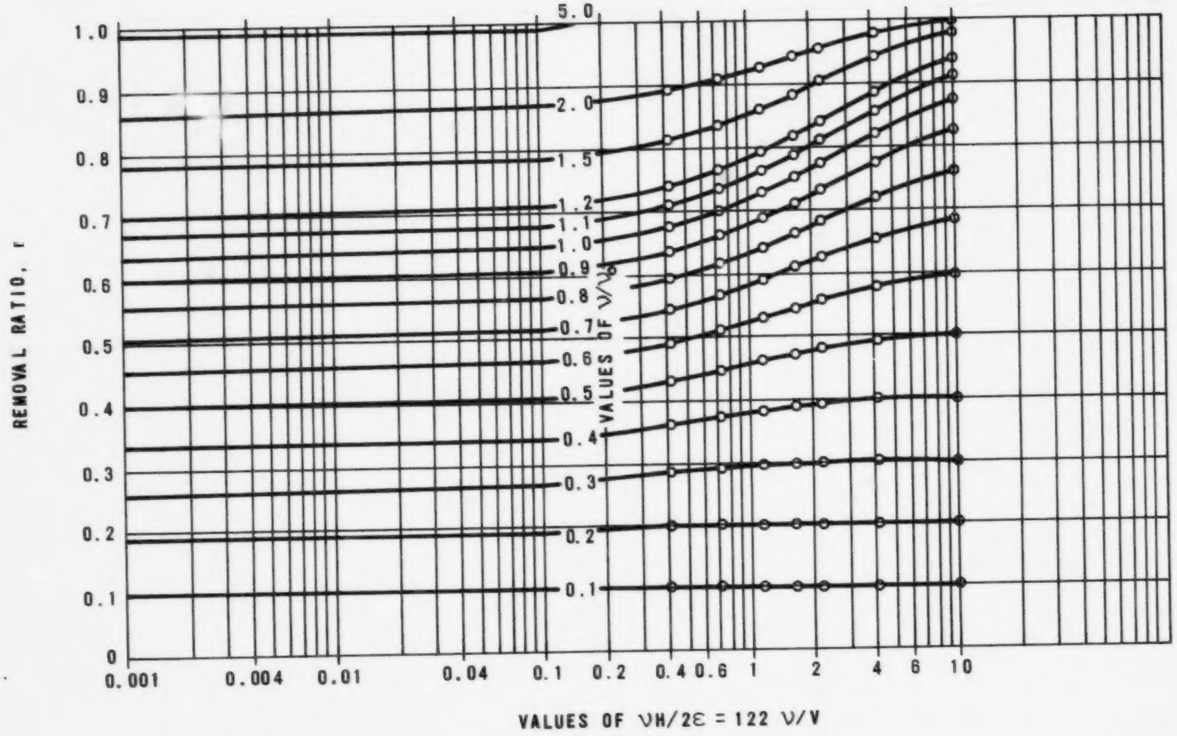


Figure C-2. Turbulence factor r as a function of ν, ν_o, and V [adapted from 3].

Sensitivity Analysis Method

The sensitivity analysis method of selecting variables REMSTS and REMSTB involves selecting a range of values, executing several EPAMAC runs, and then analyzing the results. By selecting values of, for example, 10%, 20% and 30%, for each variable, the user can establish the magnitude of influence variable selection will have on overflow quality. This approach is appropriate in planning analyses that do not have numerous existing sedimentation data. This approach is consistent with the broad scale performance of EPAMAC. At the close of the planning study, facilities could then be designed to achieve a desired percent removal to obtain an optimum overflow quality. Remember, the percent removal only applies to conditions during an overflow event and not average settling conditions.

The user should consider how elaborate a storage system is desired in the selection of REMSTS and REMSTB. High percent removals for these variables during peak flow conditions, say above 50%, may require sophisticated design or overdesign of facilities.

Relative Comparison Method

The second method consists of a comparison of the user's system and other existing stormwater systems. Also compared are the settling characteristics of the user wastewater and the curves shown in Figure C-1.

It is recommended the user first conduct a settling column test on a wastewater sample to obtain settling velocity information. If the data plots on Figure C-1 in a similar manner as the other curves, then the user may proceed with this method of variable selection. If however, it appears the wastewater is of a radically different nature, then comparison with other facilities is not expected to yield valid results. The user should then try the sensitivity method or the detailed method.

In the case where the settling data seem to follow the pattern shown in Figure C-1, then the user should examine the facilities listed in Table C-1 for the closest resemblance to the physical system the user is analyzing. Alternatively, other facilities not listed in Table C-1 can be compared if settling data for the wastewater typical of the facility are available for comparison, and are similar to the user's wastewater. When a match is established based on physical characteristics, system operation, and settling velocity curves, the user can then choose the percent removal values from the similar system as REMSTS and REMSTB.

Table C-1. REMOVALS REPORTED

Facility	Contributary area, acres	Volume	Length	Width, ft	Depth, ft	Maximum flowrate	% SS removal REMSTS	% BOD_5 removal REMSTB
Middlesex County Connecticut, industrial site, two sequential ponds	50						95	--
Pond 1		88×10^3 ft^3	350 ft	50	5.0	22 ft^3/s		
Pond 2		500×10^3 ft^3	65,000 ft^2[a]	--	5.5	34 ft^3/s		
Montgomery County, Maryland, Montgomery Mall Lake	148	3.4×10^6 ft^3	750 ft	350	13	22 ft^3/s (in) 2 ft^3/s (out)	92	80-90
Saginaw, Michigan, Hancock Street facilities	1,600	4.3 Mgal[b] 3.5 Mgal[c]	206 ft/ basin	52/ basin	10	520 Mgal/d 8,100 gal/ $ft^2 \cdot d$	70	40-60

a. Area.

b. Inline storage volume.

c. Sedimentation basin volume.

acre x 0.405 = ha
ft x 0.305 = m
ft^2 x 0.0929 = m^2
ft^3 x 0.0283 = m^3
ft^3/s x 0.283 = m^3/s
Mgal x 3,785 = m^3
Mgal/d x 0.0438 = m^3/s

The user is cautioned in using percent removals from other facilities. Do not use the highest percentage reported. Most of these values will be average storm or annual average removals. Choose values somewhat lower (30 to 40% lower) to more closely approximate the percentage removal that will occur during overflow conditions.

Reports that could be examined for information on facilities are:

1. Urban Stormwater Management and Technology: An Assessment [5]
2. Urban Stormwater Management and Technology: Update and Users' Guide [6]
3. Urban Stormwater Management and Technology: Case Histories [7]

Detailed Method

The third method is based on theoretical work by Camp and Dobbins and on a study conducted for the San Francisco Southwest Treatment Plant Project Facilities Plan [8]. The San Francisco study analyzed a storage transport facility, the Westside Transport, for possible sediment deposition. The conclusion from the study was at most a 20% reduction in suspended solids load would occur at peak flow conditions. A description of the San Francisco system is presented first. The procedure for the detailed method is then outlined using San Francisco data as an example. The information presented here is a summary of the detailed steps taken. A user wishing to conduct an analysis should refer to articles referenced in this appendix and sedimentation theory texts for complete guidance.

The Westside Transport (WST) facility is a 13,400 ft (4,084 m) long box structure with average depth of 13 ft (4.0 m). The width of the box structure is 25 ft (7.6 m). The maximum withdrawal rate for WST in the study is 240 Mgal/d (10.5 m^3/s). The wastewater is combined sanitary and stormwater flow with settling velocity ( ) characteristics as shown in Figure C-1. Horizontal velocities (V) during steady state overflow conditions are 0.65 ft/s (0.20 m/s). The overflow rate (ν_o) for WST as determined in the following methodology is 0.0132 ft/s (0.004 m/s) or 8,500 $gal/ft^2 \cdot d$ (346 $m^3/m_2 \cdot d$).

The procedure for using the data consists of four steps:

1. From system physical data and settling column analyses, calculate the parameters V and ν_o.
2. From sieve analysis, select values of ν.
3. Determine values for r using ν_o, V, and ν.
4. Using the sieve analysis data, calculate the weighted removal ratios for the various particle settling velocities to obtain an average removal value for REMSTS.

The first step requires the development of settling column analyses and settling velocity curves as shown in Figure C-1. Next, determine the physical dimensions of a storage facility typical of the system being analyzed. Also, from the EPAMAC input data, note the maximum withdrawal capacity of the system. If the maximum pumping capacity does not pass through the storage facility, adjust the flow appropriately to match the storage unit under the unit's maximum flow conditions. The user should compare the settling velocity curve for the wastewater with other curves in Figure C-1 to determine any similarities.

After collecting all the data, calculate values for the horizontal velocity and overflow rate. The horizontal velocity (V) is calculated by dividing the maximum withdrawal flowrate by the cross-sectional area of the storage unit and applying appropriate conversion factors. The overflow rate (ν_o) is defined as being equal to the maximum withdrawal flowrate divided by the storage unit surface area.

The second step determines settling velocity values ( ). After conducting a sieve analysis, select values of corresponding to each sieve size collected.

The third step computes values of the turbulence reduction factor (r). Studies by Camp and Dobbins [3, 4] determined that r can be expressed as a function of ν_o, V, and ν. To determine r, use Figure C-2. Develop a table of values of ν/ν_o and 122 (ν/V) for each value of ν from the sieve analysis, as shown in Table C-2. Then enter Figure C-2 and read the values of r for each ν. A value of ν developed from San Francisco data is 10 to 20% based on the following: flow = 371.3 ft^3/s (10.5 m^3/s); length = 1,400 ft (427 m); width = 25 ft (7.6 m); depth = 15 ft (4.6 m); and particle settling velocity range = 0.00328 to 0.0000328 ft/s (0.1 to 0.001 cm/s).

Table C-2. EXAMPLE OF DATA FOR FIGURE C-2

ν, ft/s	ν_o, ft/s	V, ft/s	ν/ν_o[a]	112 ν/V	r
0.006	0.0011	0.65	5.6	1.27	1.00
0.003	0.0011	0.65	3.0	0.62	0.96
0.0006	0.0011	0.65	0.6	0.12	0.46
0.0003	0.0011	0.65	0.3	0.062	0.26
0.00003	0.0011	0.65	0.03	0.0062	0.00

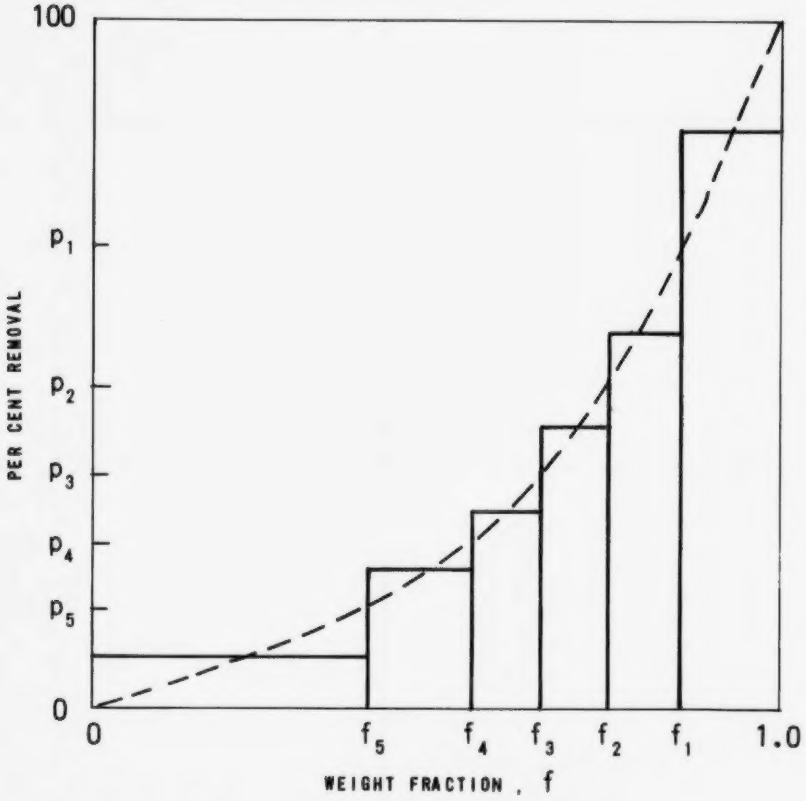
a. For $\nu/\nu_o \leq 0.05$, r = 0.00.

ft/s x 0.305 = m/s

The fourth step of the procedure uses the r values for each ν, and sieve analysis data to derive an average removal value. The weighted removal value is equivalent to the area under the curve of a plot of percentage removal (r) versus weight fraction for each settling velocity. Such a curve is shown in Figure C-3. The area can be approximated by planimetering or by rectangle approximation. The later method is shown in Figure C-3. The resultant number is REMSTS.

The detailed method does not rigorously calculate BOD removal values. The user calculates removal for SS and then must relate BOD to the SS value. The user, for example, can select an efficiency comparing SS and BOD; say BOD is one-half as efficiently removed as SS, REMSTB would then have a value of one-half the value of REMSTS. System specific characteristics and user judgment should determine this ratio.

Before embarking in such a detailed analysis as Method 3, the user is reminded that the accuracy obtained may be lost in the overall broad scale accuracy of EPAMAC. Carefully weigh the goals of an EPAMAC analysis and the effort justified in determining values of REMSTS and REMSTB.



$$p_{avg} = (f_5 - 0)\left(\frac{p_5 + 0}{2}\right) + (f_4 - f_5)\left(\frac{p_4 + p_5}{2}\right) + (f_3 - f_4)\left(\frac{p_3 + p_4}{2}\right) +$$

$$(f_2 - f_3)\left(\frac{p_2 + p_3}{2}\right) + (f_1 - f_2)\left(\frac{p_1 + p_2}{2}\right) + (1.0 - f_1)\left(\frac{100 - p_1}{2}\right)$$

$= \text{REMSTS}$

f_5 AND p_5 ARE FOR SETTLING VELOCITY ν_5, ETC.

Figure C-3. Example of percent removal versus weight fraction.